

**East Bay Habitat for Humanity, Inc.
10800 Edes Avenue Site
Oakland, California
Targeted Brownfields Assessment
Phase II Investigation
Sampling and Analysis Plan**

**USACE Delivery Order Number: W912P7-05-F-0049
Document Control Number: 12767.061.003**

November 2005

**Prepared for:
U.S. Environmental Protection Agency
Region 9**

**Prepared by:
Weston Solutions, Inc.
1575 Treat Boulevard, Suite 212
Walnut Creek, California 94598**

**East Bay Habitat for Humanity, Inc.
10800 Edes Avenue Site
Oakland, California
Targeted Brownfields Site Assessment
Phase II Investigation
Sampling and Analysis Plan**

**USACE Delivery Order Number: W912P7-05-F-0049
Document Control Number: 12767.061.003**

Approved by: _____
Joe De Fao, Project Manager
Weston Solutions, Inc.

Approved by: _____
Susanne Perkins, USEPA Task Monitor
U.S. Environmental Protection Agency, Region 9

Approved by: _____
Teresita Salire, USACE Task Monitor
U.S. Army Corps of Engineers

Approved by: _____
Eugenia E. McNaughton, Ph.D., USEPA Quality Assurance Office
U.S. Environmental Protection Agency, Region 9

TABLE OF CONTENTS

| Section | Page |
|--|-------------|
| 1.0 INTRODUCTION | 1 |
| 1.1 Project Organization | 1 |
| 1.2 Distribution List | 2 |
| 1.3 Statement of the Specific Problem | 3 |
| 2.0 BACKGROUND | 4 |
| 2.1 Location and Description | 4 |
| 2.2 Operational History | 4 |
| 2.3 Previous Investigations and Regulatory Involvement | 5 |
| 2.4 Geologic and Hydro geologic Information | 5 |
| 3.0 PROJECT OBJECTIVES | 8 |
| 3.1 Project Task and Problem Definition | 8 |
| 3.2 Data Use Objectives | 8 |
| 3.3 Action Levels | 8 |
| 3.4 Decision Rules | 11 |
| 3.5 Data Quality Objectives | 11 |
| 3.5.1 Data Quality Objective (DQO) Process | 11 |
| 3.5.2 DQO Data Categories | 11 |
| 3.5.3 Data Quality Indicators | 11 |
| 3.6 Data Management | 12 |
| 3.7 Schedule of Sampling Activities | 12 |
| 3.8 Special Training Requirements/Certifications | 12 |
| 4.0 SAMPLING RATIONALE | 14 |
| 4.1 Sampling Locations and Rationale | 14 |
| 4.1.1 Soil Sampling | 15 |
| 4.1.1.1 Greenhouse Areas | 15 |
| 4.1.1.2 Boiler Room Areas | 15 |
| 4.1.1.3 Gasoline/Diesel Tank Area | 16 |
| 4.1.1.4 Debris Area | 16 |
| 4.1.2 Groundwater Sampling | 17 |
| 4.2 analyte of Concern | 17 |
| 5.0 ANALYTICAL METHODS | 19 |

| | | |
|------------|--|-----------|
| 6.0 | METHODS AND PROCEDURES | 34 |
| 6.1 | Field Equipment | 34 |
| 6.1.1 | Sampling Equipment | 34 |
| 6.1.2 | Inspection/Acceptance Requirements for Supplies and Consumables .. | 34 |
| 6.2 | Sampling Procedures | 34 |
| 6.2.1 | Soil Sampling | 35 |
| 6.2.2 | Groundwater Sampling | 35 |
| 6.3 | Decontamination Procedures | 35 |
| 6.4 | Borehole Abandonment Procedures | 36 |
| 7.0 | DISPOSAL OF INVESTIGATION-DERIVED WASTE | 37 |
| 8.0 | SAMPLE IDENTIFICATION, DOCUMENTATION AND SHIPMENT | 38 |
| 8.1 | Field Notes | 38 |
| 8.1.1 | Field Logbooks | 38 |
| 8.1.2 | Photographs | 39 |
| 8.2 | Sample Nomenclature | 39 |
| 8.3 | Container, Preservation, and Holding Time Requirements | 39 |
| 8.4 | Sample Labeling, Packaging and Shipping | 40 |
| 8.5 | Chain of Custody Forms and QA/QC Summary Forms | 40 |
| 9.0 | QUALITY ASSURANCE AND CONTROL (QA/QC) | 42 |
| 9.1 | Field Quality Control Samples | 42 |
| 9.1.1 | Assessment of Field Contamination (Blanks) | 42 |
| 9.1.1.1 | Equipment Blanks | 42 |
| 9.1.1.2 | Temperature Blanks | 42 |
| 9.1.2 | Assessment of Sample Variability (Field Duplicate Samples) | 42 |
| 9.2 | Laboratory Quality Control Samples | 43 |
| 9.3 | Analytical and Data Package Requirements | 43 |
| 9.4 | Data Validation | 44 |
| 9.5 | Field Variances | 45 |
| 9.6 | Assessment of Project Activities | 45 |
| 9.6.1 | WESTON Assessment Activities | 45 |
| 9.6.2 | EPA Assessment Activities | 46 |
| 9.6.3 | Project Status Reports to Management | 46 |
| 9.6.4 | Reconciliation of Data with DQOs | 46 |

APPENDICES

Appendix A: Data Quality Objective Process Worksheet

Appendix B: Site-Specific Health and Safety Plan

Appendix C: Data Quality Indicators

Appendix D: Visual Sampling Plan Worksheets

Appendix E: Standard Operating Procedures

LIST OF TABLES

| Table | Page |
|--|-------------|
| Table 1-1: Organizational Chart | 2 |
| Table 3-1: Action Levels | 9 |
| Table 3-2: Data Quality Indicators | 13 |
| Table 5-1: Request for Analytical Services; Matrix - Soil | 20 |
| Table 5-2: Request for Analytical Services; Matrix - Groundwater | 32 |

LIST OF FIGURES

| Figure | Page |
|---------------------------------------|-------------|
| Figure 2-1: Site Location Map | 6 |
| Figure 2-2: Site Layout Map | 7 |
| Figure 4-1: Sample Location Map | 18 |

LIST OF ACRONYMS

| | |
|---------|--|
| AOC | Analyte of Concern |
| BEC | Brighton Environmental Consulting |
| bgs | below ground surface |
| BTEX | Benzene, Toluene, Ethyl benzene, total Xylenes |
| C | Degrees Celcius |
| CRDL | Contract Required Detection Limits |
| CRQL | Contract Required Quantitation Limit |
| DQO | Data Quality Objective |
| DQI | Data Quality Indicator |
| DTSC | California Department of Toxic Substances Control |
| EBHH | East Bay Habitat for Humanity |
| EPA | United States Environmental Protection Agency |
| ERT | Environmental Response Team |
| ESL | RWQCB Environmental Screening Level |
| FID | Flame-Ionization Detector |
| GPS | Global Positioning System |
| HDPE | High density polyethylene |
| HPLC | High Performance Liquid Chromatography |
| IDW | Investigation-Derived Waste |
| LCS | Laboratory Control Sample |
| mg/kg | milligrams per kilogram |
| µg/l | micrograms per liter |
| MS/MSD | Matrix Spike/Matrix Spike Duplicate |
| NCP | National Contingency Plan |
| OERR | Office of Emergency and Remedial Response |
| PAH | Polynuclear Aromatic Hydrocarbon |
| PCB | Polychlorinated Biphenyl |
| PID | Photo-Ionization Detector |
| PM | Project Manager |
| PPE | Personal Protective Equipment |
| PRG | Preliminary Remedial Goal |
| PVC | Polyvinyl chloride |
| QA | Quality Assurance |
| QAO | Quality Assurance Office |
| QC | Quality Control |
| RPD | Relative Percent Difference |
| RCRA | Resource Conservation and Recovery Act |
| RBSL | Risk Based Screening Level |
| RWQCB | San Francisco Bay Regional Water Quality Control Board |
| SAP | Sampling and Analysis Plan |
| SOP | Standard Operating Procedure |
| TBD | To Be Determined |
| TBSA | Targeted Brownfields Site Assessment |
| TIC | Tentatively identified compound |
| TM | Task Monitor |
| TPH-d,o | Total Petroleum Hydrocarbons as diesel and motor oil |
| TPH-g | Total Petroleum Hydrocarbons as gasoline |
| USACE | United States Army Corps of Engineers |
| VOCs | Volatile Organic Compound |
| VSP | Battelle Memorial Institute's <i>Visual Sampling Plan</i> , version 3.0 software |
| WESTON | Weston Solutions, Inc. |

1.0 INTRODUCTION

The U.S. Environmental Protection Agency (EPA), Region 9, in coordination with the U.S. Army Corps of Engineers (USACE), tasked Weston Solutions, Inc. (WESTON) to conduct a Targeted Brownfields Site Assessment (TBSA) Phase II Investigation at 10800 Edes Avenue (site), located in Oakland, Alameda County, California. The EPA Region 9 TBSAs are intended to characterize conditions at Brownfields sites being considered for planned redevelopment or reuse. East Bay Habitat for Humanity, Inc. (EBHH) plans to purchase the property for redevelopment as low-income single family homes.

The objectives of the sampling effort are to determine whether soil and groundwater at the site have been impacted by analytes of concern (AOCs) greater than set action levels from historic site uses.

This Sampling and Analysis Plan (SAP) describes the project and data use objectives, data collection rationale, quality assurance goals, and requirements for sampling and analysis activities. The SAP also defines the sampling and data collection methods that will be used for this project. The SAP is intended to accurately reflect the planned data-gathering activities for this site investigation; however, site conditions and additional EPA direction may warrant modifications. All significant changes will be documented in the final report. If problems are encountered and additional characterization of the site is indicated, an addendum will be made to the plan that documents these findings and provides procedures and a design for additional site characterization.

1.1 Project Organization

The following is a list of project personnel and their responsibilities:

EPA Task Monitor (TM) - The EPA TM is Susanne Perkins. Ms. Perkins is the primary decision maker for this investigation.

EPA Quality Assurance (QA) Manager - The EPA QA Manager is Eugenia E. McNaughton, Ph.D. Ms. McNaughton is responsible for EPA Quality Assurance Office (QAO) review of the SAP and to ensure project quality assurance goals are met.

USACE TM - The USACE TM is Teresita Salire. Ms. Salire is the primary contact for the WESTON Project Manager (PM).

WESTON PM and Field Sampling Quality Control (QC) Coordinator - The WESTON PM and Field Sampling QC Coordinator is Joe De Fao. Mr. De Fao is responsible for the overall performance of all tasks assigned to WESTON by the EPA and working with the EPA QAO to ensure project quality assurance goals are met.

WESTON Site Leader - The WESTON Site Leader is Tom Fortner. Mr. Fortner is responsible for preparing the SAP; implementing the sampling design; collecting, handling, documenting, and transporting samples; and generating field documentation of sampling activities.

EBHH Project Manager - The EBHH project manager is Michael Chao. Mr. Chao manages the planned purchase and redevelopment of the site for residential housing.

EBHH Technical Advisor - The EBHH technical advisor is Robert Roat, P.E., Brighton Environmental Consulting (BEC). Mr. Roat conducts technical reviews for EBHH under the direction of Michael Chao.

Analytical Laboratory - WESTON subcontracted laboratory for analytical services. WESTON personnel will perform data validation activities.

Table 1-1: Organizational Chart

| Title/Responsibility | Name | Phone Number |
|--|------------------------------|----------------|
| EPA Task Monitor | Susanne Perkins | (415) 972-3208 |
| EPA Quality Assurance Manager | Eugenia E. McNaughton, Ph.D. | (415) 972-3411 |
| USACE Task Monitor | Teresita Salire | (415) 977-8300 |
| East Bay Habitat for Humanity Project Manager | Michael Chao | (510) 251-6304 |
| Technical Advisor for EBHH | Robert Roat | (510) 919-4358 |
| WESTON Project Manager and Field Sampling QC Coordinator | Joe De Fao | (925) 948-2657 |
| WESTON Field Manager | Tom Fortner | (925) 948-2655 |

1.2 Distribution List

Copies of the final SAP will be distributed to the following persons and organizations:

- Susanne Perkins, EPA Region 9
- Gail Jones, EPA Region 9 QAO
- Teresita Salire, USACE
- Michael Chao, EBHH
- Robert Roat, BEC
- WESTON files

1.3 Statement of the Specific Problem

The site is currently used for the recycling of bricks by a construction and demolition business and was previously used as a plant nursery. From the mid to late 1900s, several greenhouses were located on the property. It is suspected that one or two boiler rooms and a gasoline fuel tank were located on the property. Several facilities in proximity of the site are reported to have released contaminants to the environment. Previous and current activities in and around the site may have caused soil and groundwater contamination that could impact the health and welfare of future site occupants.

EBHH has received an EPA Brownfields Assessment Grant to investigate the site that may be purchased for a residential housing development. Findings from the *Phase I Environmental Site Assessment 10800 Edes Avenue, Oakland California* prepared by BEC in September 2005 (Phase I) were incorporated into this SAP. No sampling and analysis has been performed to determine the presence or absence of contamination in soil or groundwater from historic operations.

2.0 BACKGROUND

2.1 Location and Description

As shown in Figure 2-1, the site is located at 10800 Edes Avenue, Oakland, California (Latitude 37° 43' 52" North, Longitude 112° 10' 34" West). The site occupies approximately 1.8 acres, with 0.1 acres beneath Edes Avenue, in an industrial and residential area of Oakland. The site is rectangular in shape having approximate dimensions of 228 feet by 325 feet. The site is bordered by an industrial park to the northwest, Southern Pacific Railroad to the northeast, and an undeveloped property owned by EBHH to the southeast at 10900 Edes Avenue. The southwest property boundary runs along the center line of Edes Avenue; residential housing is located across the road. The site is currently undeveloped and debris, ranging from general trash to concrete and bricks, is distributed throughout the site. San Leandro Creek is located approximately 0.25 mile south of the site and the San Francisco Bay is approximately 2 miles to the southwest. The site layout is presented in Figure 2-2.

The EBHH property located at 10900 Edes Avenue operated as a nursery and gardening outlet with eight greenhouses from at least 1926 to 1952. Between 1952 and 2000, the property was used as a truck dismantling and salvage yard. Soil at the site was contaminated with lead, Polynuclear Aromatic Hydrocarbons (PAHs) and Polychlorinated Biphenyls (PCBs) at concentrations above EPA Preliminary Remediation Goals (PRGs). An underground storage tank was removed from the southwest portion of the property. EBHH remediated the site with a loan from the State of California and a Brownfields Cleanup Grant from the EPA. The California Department of Toxic Substances Control (DTSC) issued a "no further action" letter in September 2005.

The Phase I report indicated that the property located at 750 107th Avenue was occupied by Hard Chrome Engineering, a chrome plating shop. The former plating shop is located across the railroad tracks, approximately 475 feet northeast of the site and is presumed to be upgradient of the site. The DTSC reports that the former chrome plating operation was a source of chromium detected in groundwater beneath the site. Plating shops often use other chemicals including halogenated solvents in plating operations.

The property located northwest of the site is reported to be a former foundry and is currently used for light industrial warehouses. Recent aerial photographs of the area shows the undeveloped portion of this property being used for the storage of automobiles.

2.2 Operational History

From the early 1920s to 1965, the site was used as a plant nursery. Former operations at the site utilized seven individual greenhouses, two boiler rooms, and a suspected gasoline fuel tank. Other former site structures included a caretakers house and garage. The nursery was known to grow roses for part of the site's history.

The property is owned by Evans Brothers Construction, who have operated a construction and demolition business at the site since 1982. The site was mostly used for the cleaning and recycling of bricks. Crushed bricks and asphalt grindings were used to stabilize the central and northern portions of the site. The site has recently been subjected to illegal dumping of garbage and debris.

2.3 Previous Investigations and Regulatory Involvement

A Phase I Environmental Site Assessment has been conducted on the site for EBHH, no other known investigations have been conducted at the site.

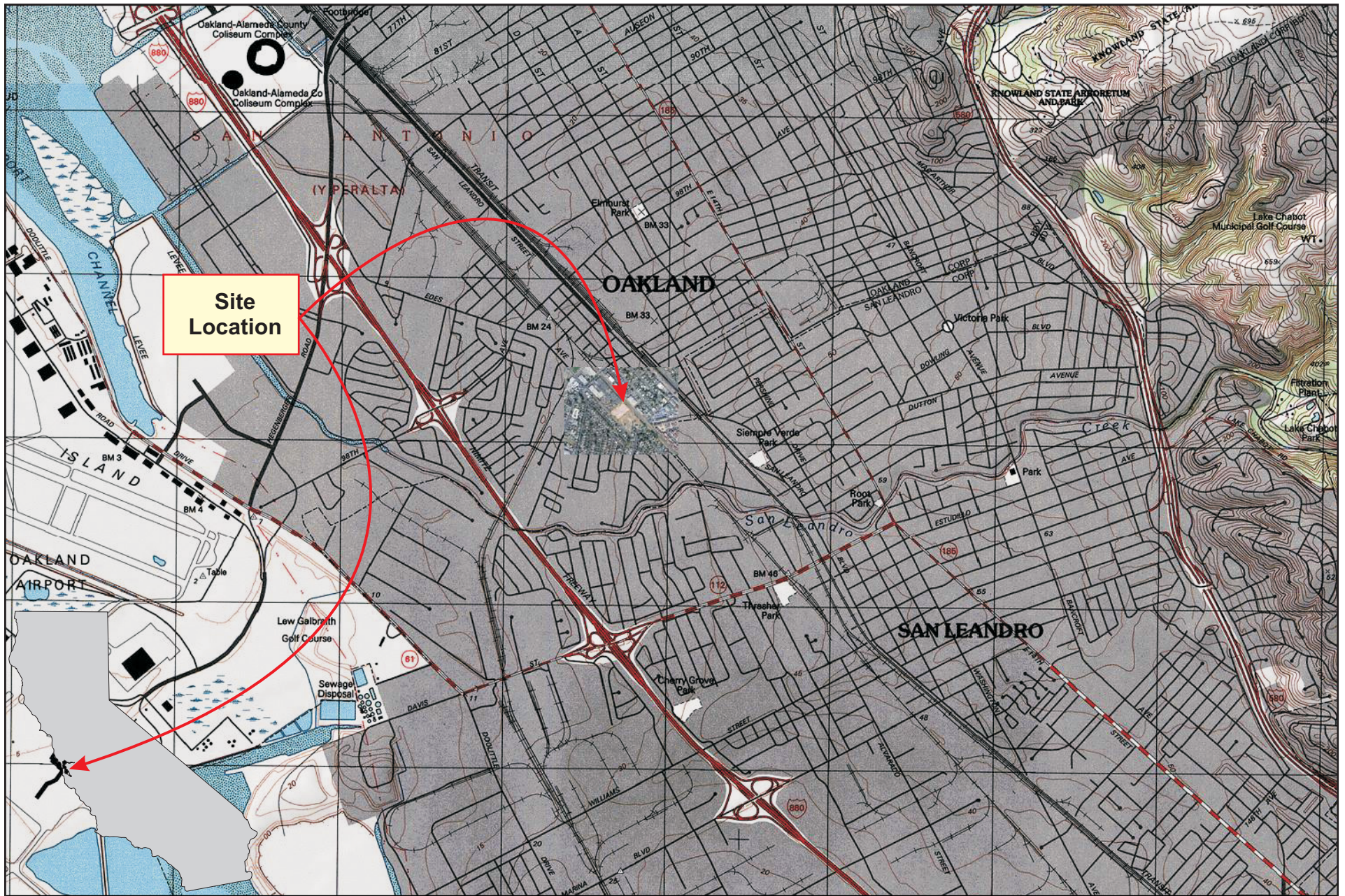
2.4 Geologic and Hydrogeologic Information

The site lies within the San Leandro Subarea, located in the East Bay Plain Groundwater Basin. The East Bay Plain Groundwater Basin is bounded on the north by San Pablo Bay, on the east by the contact with Franciscan Basement rock, and on the south by Niles Cone Groundwater Basin. The East Bay Plain Groundwater Basin extends beneath the San Francisco Bay to the west.

Water bearing units in the East Bay Plain Groundwater Basin aquifer system consist of unconsolidated sediments of Quaternary age. Deposits include the early Pleistocene Santa Clara Formation, the late Pleistocene Alameda Formation, the early Holocene Temescal Formation, and Artificial Fill. The cumulative thickness of the unconsolidated sediments is about 1,000 feet. The Santa Clara Formation consists of alluvial fan deposits inter-fingered with lake, swamp, river channel, and flood plain deposits. The Santa Clara Formation ranges from 300 to 600 feet thick. The Alameda Formation includes a sequence of alluvial fan deposits bounded by mud deposits on the top and bottom. The Alameda Formation was deposited primarily in an estuarine environment and ranges from 26 to 245 feet thick. The Temescal Formation is an alluvial deposit consisting primarily of silts and clays with some gravel layers. The Temescal Formation ranges from 1 to 50 feet thick. Artificial fill is found mostly along the San Francisco Bay front and wetland areas and is derived primarily from dredging as well as quarrying, construction, demolition debris, and municipal waste. The fill ranges from 1 to 50 feet with the thickest deposits found nearer to San Francisco Bay.

Historic water levels in the deep (more than 500 feet) aquifer in the basin have varied between 10 and 40 feet below ground surface (bgs) since the early 1950s. The low water level was reached in about 1962. Shallower aquifers have a much less pronounced water level decline. The historical low water level for aquifers at a depth of about 250 feet bgs has been about 30 feet bgs since 1950. Water levels rose about 5 feet per year between 1965 and 1980. Water levels have been rising continuously since then, but at a less rapid rate. As of 2000, water levels are very near ground surface in all aquifers.

Groundwater was encountered during a subsurface investigation at the 10900 Edes Avenue site at depths ranging from 19 to 24 feet; similar depths to groundwater are anticipated for the 10800 Edes Avenue site. Based on the topography of the area, groundwater flow is likely to be towards the southwest towards San Francisco Bay.

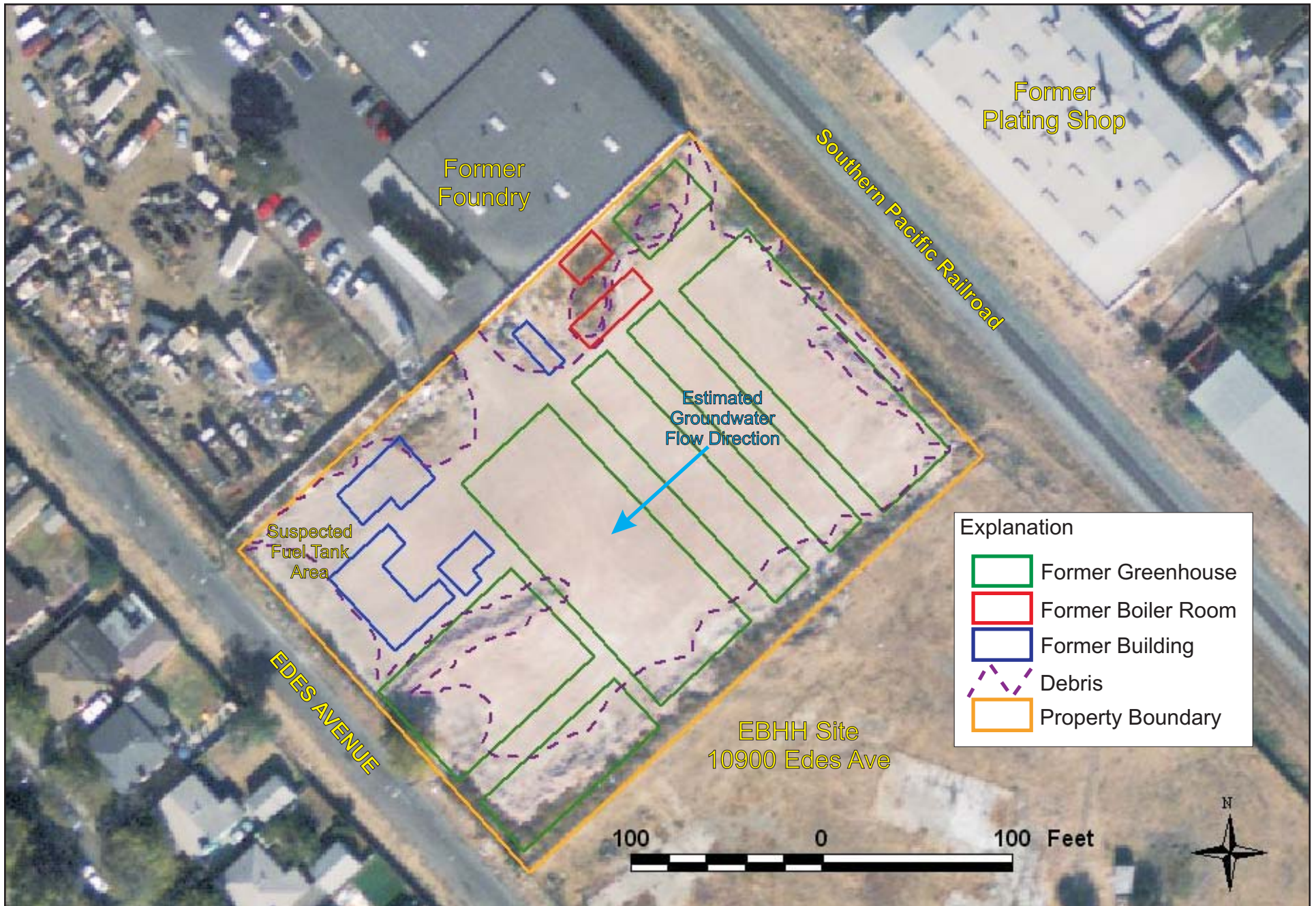


TN 15°

0 1000 FEET 0 500 1000 METERS
Map created with TOPO!® ©2002 National Geographic (www.nationalgeographic.com/topo)



Site Location Map
10800 Edes Avenue
Oakland, California



3.0 PROJECT OBJECTIVES

3.1 Project Task and Problem Definition

Under the Brownfields program, the EPA, in coordination with the USACE, has tasked WESTON to conduct a soil and groundwater investigation to evaluate site environmental concerns in an effort to facilitate redevelopment. To evaluate environmental concerns, WESTON will collect soil samples from 50 boring locations to be analyzed for AOCs including asbestos, Resource Conservation and Recovery Act (RCRA) metals, organochlorine pesticides, total petroleum hydrocarbons (TPH) as diesel and motor oil (TPH-d,o), TPH as gasoline (TPH-g), benzene, toluene, ethyl benzene and total xylenes (BTEX), and/or PAHs. Four groundwater samples will be collected and analyzed for RCRA metals and pesticides, TPH-d and TPH-g, BTEX, PAHs, and/or volatile organic compounds (VOCs). Sample results will be evaluated against action levels to determine the risk to human health and the environment and to determine disposal requirements.

3.2 Data Use Objectives

The data collected during this site investigation will be used to evaluate environmental concerns at the site and identify the potential impact to future development. The data will be specifically used to determine if soil and groundwater have been impacted by historic uses and to support disposal redevelopment decisions.

3.3 Action Levels

The EBHH is tentatively planning to redevelop the site into a residential housing development. Because protection of human health and protection of groundwater and the environment are pertinent to this site use, soil results will either be compared to the Oakland Urban Land Redevelopment Program's Tier-1 risk-based screening levels (RBSLs) (January 2001) for surficial soil or to EPA Region 9 PRGs for residential soil (October 2004). Groundwater results will either be compared to RBSLs for inhalation of indoor vapors or San Francisco Bay Regional Water Quality Control Board (RWQCB) Environmental Screening Levels (ESLs) for residential land use for shallow soil where groundwater is not a potential source of drinking water. The EPA will make the final determination based on a site-specific evaluation of all available data.

The AOCs for the project are listed in Table 3-1 along with associated action levels. The AOCs listed in Table 3-1 were selected by the scoping team based on professional judgement for the analytes expected to be present at the site. If analytes not listed in Table 3-1 are detected, the sample results will be presented and discussed in the final report.

| Table 3-1: Action Levels, EBHH Targeted Brownfields Assessment Phase II Investigation | | | | |
|--|------------------|------------------|-----------------|----------------|
| Analyte | Soil | | Groundwater | |
| | RBSLs (mg/kg) | PRGs (mg /kg) | RBSLs (µg/l) | ESLs (µg/l) |
| Inorganics | | | | |
| Asbestos | - | 1% NESHAP | - | - |
| Arsenic | 0.32 | 0.39 / 0.062* | - | 36 |
| Barium | 5,200 | 5,400 | - | 1000 |
| Cadmium | 37 | 37 | - | 1.1 |
| Total Chromium | 74,000 | 210 | - | 180 |
| Lead | - | 400/150* | - | 2.5 |
| Mercury | 4.7 | 23 | 260 | 0.012 |
| Selenium | 370 | 390 | - | 5 |
| Silver | 370 | 390 | - | 0.19 |
| Polynuclear Aromatic Hydrocarbons | | | | |
| Acenaphthene | 3,100 | 3,700 | >SOL | 23 |
| Anthracene | 16,000 | 22,000 | >SOL | 0.73 |
| Benzo (a) anthracene | 0.25 | 0.62 | >SOL | 0.027 |
| Benzo (a) pyrene | 0.025 | 0.062 | >SOL | 0.014 |
| Benzo (b) fluoranthene | 0.25 | 0.62 | >SOL | 0.029 |
| Benzo (k) fluoranthene | 0.25 | 6.2/0.38* | >SOL | 0.4 |
| Chrysene | 2.5 | 62/3.8* | >SOL | 0.35 |
| Dibenzo (a,h) anthracene | 0.074 | 0.062 | >SOL | 0.25 |
| Fluoranthene | 2,100 | 2,300 | >SOL | 8 |
| Fluorene | 2,100 | 2,700 | >SOL | 3.9 |
| Indeno (1,2,3-cd) pyrene | 0.25 | 0.62 | >SOL | 0.029 |
| Naphthalene | 2,000 | 56/1.7* | >SOL | 24 |
| Pyrene | 1,600 | 2,300 | >SOL | 2 |

| Table 3-1: Action Levels, EBHH Targeted Brownfields Assessment Phase II Investigation (Continued) | | | | |
|--|------------------|------------------|-----------------|----------------|
| Analyte | Soil | | Groundwater | |
| | RBSLs (mg/kg) | PRGs (mg /kg) | RBSLs (µg/l) | ESLs (µg/l) |
| Pesticides | | | | |
| Aldrin | - | 0.029 | - | 0.13 |
| Chlordane | - | 1.6 | - | 0.004 |
| DDD | - | 2.4 | - | 0.001 |
| DDE | - | 1.7 | - | 0.001 |
| DDT | - | 1.7 | - | 0.001 |
| Dieldrin | - | 0.03 | - | 0.0019 |
| Endosulfan | - | 370 | - | 0.0087 |
| Endrin | - | 18 | - | 0.0023 |
| Heptachlor | - | 0.11 | - | 0.0038 |
| Heptachlor epoxide | - | 0.053 | - | 0.0038 |
| Hexachlorobenzene | - | 0.3 | - | 3.7 |
| Lindane | - | 0.09 | - | 0.08 |
| Methoxychlor | - | 310 | - | 0.019 |
| Toxaphene | - | 0.44 | - | 0.0002 |
| TPH-gasoline/TPH -diesel | 100** | - | - | 500/640 |
| Benzene | 2.7 | 0.64 | 110 | 46 |
| Toluene | 9,000 | 520 | 210,000 | 130 |
| Ethyl Benzene | 5,100 | 400 | >SOL | 290 |
| Total Xylenes | 54,000 | 270 | >SOL | 100 |
| Tetrachloroethylene (PCE) | na | na | 200 | 120 |
| Trichloroethylene (TCE) | na | na | 690 | 360 |
| Trichloroethane (TCA) | na | na | 990 | 62 |
| RBSLs = Oakland Tier 1 Risk Based Screening Levels (Jan. 2001) PRG = EPA Preliminary Remediation Goal for residential soil (Oct. 2004) ESL = RWQCB Environmental Screening Level NESHAP = National Air Emissions for Hazardous Air Pollutants * California modified PRG >SOL = RBSL exceeds solubility of chemical in water | | | | |
| mg/kg = milligrams per kilogram µg/l = micrograms per liter - = none na = not applicable TPH = Total Petroleum Hydrocarbons ** = ESL used as no RBSL has been established | | | | |

3.4 Decision Rules

Results will be evaluated against the following decision rules:

- 1) If analysis of soil samples documents concentrations of AOCs to be greater than action levels, then the EPA may request further characterization, removal, or remediation of the impacted soil or a different development plan. If analysis of soil samples document concentrations of AOCs to be less than action levels, then the EPA may request further characterization and may allow the current redevelopment plan to proceed.
- 2) If analysis of groundwater samples documents concentrations of AOCs to be greater than the action levels, then the EPA may request further characterization, removal, or remediation of the source of the contamination prior to site development. If analysis of groundwater samples documents concentrations of AOCs to be less than action levels, then the EPA may allow the current redevelopment plan to proceed.

3.5 Data Quality Objectives

3.5.1 Data Quality Objective Process

The Data Quality Objective (DQO) process, as set forth in the EPA document, *Guidance for the Data Quality Objectives Process*, EPA QA/G-4, was followed to establish the data quality objectives for this project. An outline of the process and the outputs for this project are included in Appendix A.

3.5.2 DQO Data Categories

This investigation will involve the generation of definitive data for groundwater and soil. The specific requirements for this data category are detailed in Section 9. The data generated under this project will comply with the requirements for that data category as defined in *Data Quality Objective Process for Superfund*, EPA 540/G-93/71, September 1993. All definitive analytical methods employed for this project will be methods approved by the EPA.

3.5.3 Data Quality Indicators

Data quality indicator (DQI) goals for this project were developed following guidelines in *EPA Guidance for Quality Assurance Project Plans*, EPA QA/G-5 Final. All sampling will be guided by procedures detailed in Section 6.2 to ensure representativeness of sample results. Table 3-2 and Appendix C document the DQIs for this project. As presented in Table 3-2 and Appendix C, The laboratory have reviewed the DQIs for the project and the laboratories QC criteria have been reviewed and will meet the project requirements. The laboratories Contract Required Quantitation Limits (CRQLs) were determined to be appropriate for this project.

3.6 Data Management

Samples will be collected and logged on a chain-of-custody form as discussed in Section 8.5. Samples will be kept secure in the custody of the sampler at all times, who will assure that all preservation parameters are being followed. Samples will be transferred to the laboratory via a certified carrier in a properly custody-sealed container with chain-of-custody documentation. The laboratory should note any evidence of tampering upon receipt.

The completed laboratory data report will be submitted to WESTON for validation. The data validation reports and laboratory data summary sheets will be included in the final report to be submitted to the EPA TM. Before submittal, the final report will undergo a technical review to ensure that all data have been reported and discussed correctly.

3.7 Schedule of Sampling Activities

It is anticipated that field activities will begin the week of November 7, 2005. The date of the field sampling event is contingent on the project scoping team's ability to review the SAP. Field sampling is expected to last 2 to 3 days. Subsequent to the field sampling event, samples will be analyzed, data will be evaluated and validated, and preliminary data will be tabulated approximately 2 weeks after the field sampling event. The target date for completion of the final report is January 23, 2006.

3.8 Special Training Requirements/Certifications

There are no special training or certification requirements specific to this project. Training requirements relevant to WESTON's health and safety program comply with Code of Federal Regulations, Title 29, Section 1910.120. The Site-Specific Health and Safety Plan is presented in Appendix B.

| Table 3-2: Data Quality Indicators | | | | | | |
|--|--------|--|---|---|--|---------------------|
| Method Number (Method Name) | Matrix | Action Level (mg/kg soil) (µg/l water) | CRQL (mg/kg soil) (µg/l water) | Accuracy (% Recovery MS/MSD) | Precision (RPD for MS/MSD and dups.) | Percent Complete |
| EPA 600/R-93/116 Asbestos | Soil | See App. C | See App. C | - | - | - |
| EPA 6010B/7470/71 RCRA Metals | Soil | See App. C | See App. C | 75 - 125% | ≤ 50% | 90 - 100% |
| EPA 6010B/7470/71 RCRA Metals | Water | See App. C | See App. C | ±25% from expected value | <±35% - samples >5x CRDL; ±2xCRDL- samples <5x CRDL | 90 - 100% |
| EPA 8081A Organochlorine Pesticides | Soil | See App. C | See App. C | 50 - 135% | ≤ 30% | 90 - 100% |
| EPA 8081A Organochlorine Pesticides | Water | See App. C | See App. C | 50 - 135% | ≤ 30% | 90 - 100% |
| EPA 8270C SIMS PAHs | Soil | See App. C | See App. C | Within laboratory established limits | Within laboratory established limits | NA |
| EPA 8270C SIMS PAHs | Water | See App. C | See App. C | 75 - 125% | ≤ 35% | 90 - 100% |
| EPA 8015 Modified TPH as diesel and oil | Soil | See App. C | See App. C | 65 - 125% | ≤ 35% | 90 - 100% |
| EPA 8015 Modified TPH as diesel and oil | Water | See App. C | See App. C | 75 - 125% | ≤ 35% | 90 - 100% |
| EPA 8260B TPH as gasoline BTEX | Soil | See App. C | See App. C | 50 - 150% | ≤ 50% | 90 - 100% |
| EPA 8260B TPH as gasoline BTEX | Water | See App. C | See App. C | 65 - 135% | ≤ 30% | 90 - 100% |
| EPA 8260 Halogenated VOCs | Water | See App. C | See App. C | 65 - 135% | ≤ 30% | 90 - 100% |
| CRQL = Contract Required Quantitation Limit MS/MSD = Matrix Spike/Matrix Spike Duplicate RPD = Relative Percent Difference CRDL = Contract Required Detection Limits RCRA = Resource Conservation and Recovery Act | | | EPA = United States Environmental Protection Agency PAH = Polynuclear Aromatic Hydrocarbon TPH = Total Petroleum Hydrocarbons BTEX = Benzene, Toluene, Ethyl benzene and total Xylenes VOCs = Volatile Organic Hydrocarbons | | | |

4.0 SAMPLING RATIONALE

4.1 Sampling Locations and Rationale

The objective of this investigation is to evaluate site environmental concerns and ultimately facilitate redevelopment. WESTON has reviewed available site information to determine historic uses and identify hazardous substances that may be present on site. WESTON used this information to determine the most effective sampling design to meet the project objectives within the schedule and budgetary constraints. The following potential sources of contamination were identified at the site:

- Former Greenhouses - pesticides and metals
- Former Boiler Rooms - TPH-d,o and PAHs
- Former Fuel Tank - TPH-g and BTEX
- Debris piles and crushed bricks - TPH-d,o, PAHs, metals and asbestos
- Plating Shop (upgradient) - metals and halogenated VOCs

Based on the site history, a grid sampling approach will be used to determine the sample locations. Sampling locations were generated using Battelle Memorial Institute's *Visual Sampling Plan* version 3.0 software (VSP). A predetermined square grid size of 40 feet for the greenhouse area and a grid size of 20 feet for the boiler room, fuel tank, and debris areas were entered into VSP's hot spot sampling goals program. VSP reports are included in Appendix D. Boring depths were selected to encompass possible exposure from contaminated soil if the site is graded for development in the future, and the depth where contamination is most likely to be discovered from areas of concern.

A combination of field screening tools and laboratory data will be used as recommended by the Triad approach. This sampling approach was selected to be the most effective to meeting the investigative objectives.

A total of 200 soil samples will be collected from 50 boring locations drilled to 4 feet bgs in areas of suspected contamination. In addition, groundwater samples will be collected at four locations from beneath the site. Proposed soil and groundwater locations are illustrated in Figure 4-1. Exact sampling locations will be determined in the field based upon accessibility and visible signs of contamination (e.g., stained soils). Detailed rationale for the sample locations are presented in the following subsections. Actual sample locations will be recorded using a Global Positioning System (GPS) and entered into the field logbook as sampling is completed.

4.1.1 Soil Sampling

4.1.1.1 Greenhouse Areas

Soil samples will be collected from 28 boring locations for the greenhouse areas (EBHH-1 through EBHH-28) to assess impacts from greenhouse activities. The greenhouse area will be divided into 40-foot by 40-foot grids and one soil boring will be drilled to 4 feet bgs in each of the grids. At each location a surface sample will be collected from the surface to 0.5 feet bgs and analyzed for RCRA metals (from agricultural impacts) and asbestos (from brick recycling activities). Soil samples collected from 0.5 to 1.5 feet bgs and 1.5 to 2.5 feet bgs at each location will be analyzed for RCRA metals. Soil samples collected from 0.5 to 1.5 feet bgs and 1.5 to 2.5 feet bgs from every other boring location will be analyzed for organochlorine pesticides (impacts from the former nursery) as indicated on Figure 4-1. In addition, samples will be collected from each location at the sample depth interval of 3 to 4 feet bgs. These samples will be shipped to the laboratory and held pending analyses. If an action level is exceeded for an analyte of concern in the sample from 1.5 to 2.5 feet bgs, then the sample from 3 to 4 feet bgs will be analyzed.

Additionally, surface soil samples collected from boring locations along the southeastern property boundary will be analyzed for asbestos, RCRA metals, PAHs, and TPH-d,o to assess impacts from former debris areas. Subsurface samples from these borings will be collected from 0.5 feet to 1.5 feet bgs, 1.5 to 2.5 feet bgs, and 3 to 4 feet bgs. Each depth interval will be screened using a combination photo-ionization (PID)/flame-ionization detected (FID) to determine if organic vapors are present. Based on the PID/FID screening, soil samples exhibiting the highest organic vapor readings from each boring will be submitted for the above analyses.

4.1.1.2 Boiler Room Areas

Soil samples will be collected from eight boring locations (EBHH-29 through EBHH-36) for the boiler room areas to assess historic fuel releases. The boiler room area will be divided into 20-foot by 20-foot grids and one soil boring will be drilled to a depth of approximately 4 feet bgs in each of the grids. Samples will be collected from the following depth intervals: surface to 0.5 feet bgs, 0.5 to 1.5 feet bgs, 1.5 to 2.5 feet bgs, and 3 to 4 feet bgs. Each depth interval will be screened using a combination PID/FID to determine if organic vapors are present. Based on the PID/FID screening, soil samples exhibiting the highest organic vapor readings will be submitted for the above analyses. A total of four samples will be collected for TPH-d,o and PAH analysis and shipped to the laboratory.

Additionally, surface soil samples collected from boring locations along the northwestern property boundary will be analyzed for asbestos, RCRA metals, PAHs, and TPH-d,o to assess impacts from former debris areas. Subsurface samples from these borings will be collected from

0.5 to 1.5 feet bgs, 1.5 to 2.5 feet bgs, and 3 to 4 feet bgs. Each depth interval will be screened using a combination PID/FID to determine if organic vapors are present. Based on the PID/FID screening, soil samples exhibiting the highest organic vapor readings from each boring will be submitted for the above analyses.

4.1.1.3 Gasoline/Diesel Tank Area

Soil samples will be collected from six boring locations (EBHH-45 through EBHH-50) to assess historic gasoline/diesel releases from the suspected tank area. The gasoline/diesel tank area will be divided into 20-foot by 20-foot grids and one soil boring will be drilled to a depth of approximately 4 feet bgs in each of the grids. Samples will be collected from the following depth intervals: surface to 0.5 feet bgs, 0.5 to 1.5 feet bgs, 1.5 to 2.5 feet bgs, and 3 to 4 feet bgs. Each depth interval will be screened using a combination PID/FID to determine if organic vapors are present. Based on the PID/FID screening, soil samples exhibiting the highest organic vapor readings will be submitted for analysis. A total of four samples will be collected for TPH-d,o, TPH-g, and BTEX analyses and shipped to the laboratory.

Additionally, surface soil samples collected from boring locations in the western corner of the property will be analyzed for asbestos, RCRA metals, PAHs, and TPH-d,o to assess impacts from former debris areas. Subsurface samples from these borings will be collected from 0.5 to 1.5 feet bgs, 1.5 to 2.5 feet bgs, and 3 to 4 feet bgs. Each depth interval will be screened using a combination PID/FID to determine if organic vapors are present. Based on the PID/FID screening, soil samples exhibiting the highest organic vapor readings from each boring will be submitted for the above analyses.

4.1.1.4 Debris Area

Soil samples will be collected from eight boring locations (EBHH-37 through EBHH-44) to assess impacts from the northwestern debris area. The northwestern debris area will be divided into 20-foot by 20-foot grids and one soil boring will be drilled to a depth of approximately 4 feet bgs in each of the grids. Samples will be collected from the following depth intervals: surface to 0.5 feet bgs, 0.5 to 1.5 feet bgs, 1.5 to 2.5 feet bgs, and 3 to 4 feet bgs. Each depth interval will be screened using a combination PID/FID to determine if organic vapors are present. Based on the PID/FID screening, soil samples exhibiting the highest organic vapor readings will be submitted for TPH-d,o and PAHs analyses from each boring location.

Additionally, surface soil samples collected from boring locations along the northwestern property boundary will be analyzed for asbestos, RCRA metals, PAHs, and TPH-d,o to assess impacts from former debris areas.

4.1.2 Groundwater Sampling

The proposed groundwater sampling locations (EBHH-GW-1 through EBHH-GW-4) are presented in Figure 4-1. Groundwater sample EBHH-GW-1 will be collected from the rear of the property, downgradient from the former plating shop, and analyzed for RCRA metals and halogenated VOCs. The DTSC reports that the former plating shop had a known release of chromium to groundwater. There is also a possibility that halogenated VOCs may have been released as plating operations typically employ the use of solvents. Groundwater sample EBHH-GW-2 will be collected from the boiler room area and analyzed for TPH-d,o and PAHs. Groundwater sample EBHH-GW-3 will be collected from the gasoline/diesel tank area and analyzed for TPH-d,o, TPH-g, and BTEX. Groundwater sample EBHH-GW-4 will be collected from the downgradient portion of the site and will be analyzed for RCRA metals, pesticides, TPH-d,o, TPH-g, BTEX, halogenated VOCs and PAHs.

4.2 Analytes of Concern

Based on the site history, soil samples will be analyzed for asbestos, RCRA metals, pesticides, TPH-d,o, TPH-g, BTEX, and/or PAHs,. Groundwater samples will be analyzed for RCRA metals, pesticides, TPH-d,o, TPH-g/BTEX, PAHs, and/or halogenated VOCs. The AOCs for the site are listed in Table 3-1.



Sample Location Map
10800 Edes Avenue
Oakland, California

5.0 ANALYTICAL METHODS

Samples will be analyzed for asbestos, RCRA metals, organochlorine pesticides, TPH-d,o, TPH-g, BTEX, PAHs and/or halogenated VOCs by a Severn Trent Laboratories, Inc. (STL) of Pleasanton, California. STL is a California certified laboratory for the requested analyses. Sample containers, preservatives, holding times, and estimated number of field and QC samples are summarized in Tables 5-1 and 5-2.

As illustrated on Figure 4-1, 200 soil samples will be collected from 50 boring locations. As shown in Table 5-1, additional sample volume collected at nine locations will be identified for use as a laboratory QC sample, and field duplicate samples will be collected at 13 locations. In the greenhouse area, samples collected from the 3- to 4-foot bgs sample depth interval will have the option of being shipped to the laboratory for analysis. In addition, approximately 10 percent of samples collected in the boiler room areas and approximately 10 percent of samples collected in the gasoline/diesel tank area will be shipped to the laboratory. The total number of samples for this matrix is presented in Table 5-1. Each sample will be preserved immediately after collection and analyzed for asbestos via EPA Method 600/R-93/116, RCRA metals via EPA Method 6010, organochlorine pesticides via EPA Method 8081A, TPH-d,o via EPA Method 8015M, and TPH-g and BTEX via EPA Method 8260B, and/or PAHs via EPA Method 8270D SIMS.

As illustrated on Figure 4-1, groundwater samples will be collected from 4 locations. As shown in Table 5-2, additional sample volume collected at one location will be identified for use as a laboratory QC sample, and a field duplicate sample will be collected at one location. Equipment blanks are also included in this matrix. The total number of samples for this matrix, as indicated in Table 5-2, is 9. A total number of 5 actual groundwater samples, including a duplicate sample, will be collected. The samples will be preserved immediately after collection and analyzed for RCRA metals via EPA Method 6010, organochlorine pesticides via EPA Method 8081A, PAHs via EPA Method 8270D SIMS, TPH-d,o via EPA Method 8015M, TPH-g and BTEX via EPA Method 8260B, and/or Halogenated VOCs via EPA Method 8260B.

One equipment blank will be collected per matrix for each day that equipment is decontaminated in the field. A total of up to 4 equipment blanks are expected. As shown in Table 5-2, equipment blanks will be analyzed for RCRA metals via EPA Method 6010, organochlorine pesticides via EPA Method 8081A, PAHs via EPA Method 8270D, TPH-d,o via EPA Method 8015M, TPH-g and BTEX, via EPA Method 8260B, and/or VOCs via EPA Method 8260B in the same manner as the groundwater samples.

To provide QC for the analytical program, the following measures will be utilized:

- Additional sample volume will be collected for at least one sample per matrix per each analytical method, to be utilized for matrix spike/matrix spike duplicate (MS/MSD) analysis.
- A Contract Laboratory Program type data package will be required from the laboratory for all resultant data.

Table 5-1: Request for Analytical Services: Matrix - Soil

| Table 5-1: Request for Analytical Services: Matrix - Soil | | | | | | | | |
|--|-----------------|--------------------------|--|-------------------------------------|--------------------------------|-------------------------------|-----------------------------|---------------------------------|
| Method Number & Analysis | | | 600/R-93/116 for Asbestos (PLM) | 6010 for RCRA Metals | 8081A for Pesticide | 8270CSIMS for PAHs | 8015 for TPH-d,o | 8260B for TPH-g/BTEX |
| Preservatives | | | N/A | Chill to 4 C | Chill to 4 C | Chill to 4 C | Chill to 4 C | Chill to 4 C |
| Analytical Holding Time | | | N/A | 6 months 14 days Hg | 14 days | 14 days | 14 days | 2 days |
| Sample Volume / Sample Container | | | 1 Clear Plastic Bag | 1 x 8 oz. Glass Jar | 1 x 8 oz. Glass Jar | 1 x 8 oz. Glass Jar | 2 x 8 oz. Glass Jar | 3 x 5 gram En Core® Sampler |
| Sample Information: | | | | | | | | |
| Sample Number | Depth (feet) | Designation/ Location | 600/R-93/116 for Asbestos | 6010B for RCRA Metals | 8081A for Pesticide | 8270C for PAHs | 8015M for TPH-d,o | 8260B for TPH-g/BTEX |
| EBHH-1A | 0 - 0.5 | Greenhouse/debris | X | X | | X | X | |
| EBHH-1B | 0.5 - 1.5 | Greenhouse/debris | | X | X | (X) | (X) | |
| EBHH-1C | 1.5 - 2.5 | Greenhouse/debris | | X | X | (X) | (X) | |
| EBHH-1D | 3 - 4 | Greenhouse/debris | | X | X | (X) | (X) | |
| EBHH-2A | 0 - 0.5 | Greenhouse | X | X | | | | |
| EBHH-2B | 0.5 - 1.5 | Greenhouse | | X | | | | |
| EBHH-2C | 1.5 - 2.5 | Greenhouse | | X | | | | |
| EBHH-2D | 3 - 4 | Greenhouse | | X | | | | |
| EBHH-3A | 0 - 0.5 | Greenhouse | X | X | | | | |
| EBHH-3B | 0.5 - 1.5 | Greenhouse | | X | X | | | |
| EBHH-3C | 1.5 - 2.5 | Greenhouse | | X | X | | | |
| EBHH-3D | 3 - 4 | Greenhouse | | X | X | | | |

| Sample Number | Depth (feet) | Designation/ Location | 600/R-93/116 for Asbestos | 6010B for RCRA Metals | 8081A for Pesticide | 8270C for PAHs | 8015M for TPH-d,o | 8260B for TPH-g/BTEX |
|---------------|--------------|-----------------------|---------------------------|-----------------------|---------------------|----------------|-------------------|----------------------|
| EBHH-4A | 0 - 0.5 | Greenhouse/debris | X | X | | X | X | |
| EBHH-4B | 0.5 - 1.5 | Greenhouse/debris | | X | | (X) | (X) | |
| EBHH-4C | 1.5 - 2.5 | Greenhouse/debris | | X | | (X) | (X) | |
| EBHH-4D | 3 - 4 | Greenhouse/debris | | X | | (X) | (X) | |
| EBHH-5A | 0 - 0.5 | Greenhouse | X | X | | | | |
| EBHH-5B | 0.5 - 1.5 | Greenhouse | | X | X | | | |
| EBHH-5C | 1.5 - 2.5 | Greenhouse | | X | X | | | |
| EBHH-5D | 3 - 4 | Greenhouse | | X | X | | | |
| EBHH-6A | 0 - 0.5 | Greenhouse | X | X | | | | |
| EBHH-6B | 0.5 - 1.5 | Greenhouse | | X | | | | |
| EBHH-6C | 1.5 - 2.5 | Greenhouse | | X | | | | |
| EBHH-6D | 3 - 4 | Greenhouse | | X | | | | |
| EBHH-7A | 0 - 0.5 | Greenhouse | X | X | | | | |
| EBHH-7B | 0.5 - 1.5 | Greenhouse | | X | X | | | |
| EBHH-7C | 1.5 - 2.5 | Greenhouse | | X | X | | | |
| EBHH-7D | 3 - 4 | Greenhouse | | X | X | | | |
| EBHH-8A | 0 - 0.5 | Greenhouse | X | X | | | | |
| EBHH-8B | 0.5 - 1.5 | Greenhouse | | X | | | | |
| EBHH-8C | 1.5 - 2.5 | Greenhouse | | X | | | | |
| EBHH-8D | 3 - 4 | Greenhouse | | X | | | | |

| Sample Number | Depth (feet) | Designation/ Location | 600/R-93/116 for Asbestos | 6010B for RCRA Metals | 8081A for Pesticide | 8270C for PAHs | 8015M for TPH-d,o | 8260B for TPH-g/BTEX |
|---------------|--------------|-----------------------|---------------------------|-----------------------|---------------------|----------------|-------------------|----------------------|
| EBHH-9A | 0 - 0.5 | Greenhouse | X | X | | | | |
| EBHH-9B | 0.5 - 1.5 | Greenhouse | | X | X | | | |
| EBHH-9C | 1.5 - 2.5 | Greenhouse | | X | X | | | |
| EBHH-9D | 3 - 4 | Greenhouse | | X | X | | | |
| EBHH-10A | 0 - 0.5 | Greenhouse/debris | X | X | | X | X | |
| EBHH-10B | 0.5 - 1.5 | Greenhouse/debris | | X | | (X) | (X) | |
| EBHH-10C | 1.5 - 2.5 | Greenhouse/debris | | X | | (X) | (X) | |
| EBHH-10D | 3 - 4 | Greenhouse/debris | | X | | (X) | (X) | |
| EBHH-11A | 0 - 0.5 | Greenhouse | X | X | | | | |
| EBHH-11B | 0.5 - 1.5 | Greenhouse | | X | X | | | |
| EBHH-11C | 1.5 - 2.5 | Greenhouse | | X | X | | | |
| EBHH-11D | 3 - 4 | Greenhouse | | X | X | | | |
| EBHH-12A | 0 - 0.5 | Greenhouse | X | X | | | | |
| EBHH-12B | 0.5 - 1.5 | Greenhouse | | X | | | | |
| EBHH-12C | 1.5 - 2.5 | Greenhouse | | X | | | | |
| EBHH-12D | 3 - 4 | Greenhouse | | X | | | | |
| EBHH-13A | 0 - 0.5 | Greenhouse | X | X | | | | |
| EBHH-13B | 0.5 - 1.5 | Greenhouse | | X | X | | | |
| EBHH-13C | 1.5 - 2.5 | Greenhouse | | X | X | | | |
| EBHH-13D | 3 - 4 | Greenhouse | | X | X | | | |

| Sample Number | Depth (feet) | Designation/ Location | 600/R-93/116 for Asbestos | 6010B for RCRA Metals | 8081A for Pesticide | 8270C for PAHs | 8015M for TPH-d,o | 8260B for TPH-g/BTEX |
|---------------|--------------|-----------------------|---------------------------|-----------------------|---------------------|----------------|-------------------|----------------------|
| EBHH-14A | 0 - 0.5 | Greenhouse/debris | X | X | | X | X | |
| EBHH-14B | 0.5 - 1.5 | Greenhouse/debris | | X | | (X) | (X) | |
| EBHH-14C | 1.5 - 2.5 | Greenhouse/debris | | X | | (X) | (X) | |
| EBHH-14D | 3 - 4 | Greenhouse/debris | | X | | (X) | (X) | |
| EBHH-15A | 0 - 0.5 | Greenhouse | X | X | | | | |
| EBHH-15B | 0.5 - 1.5 | Greenhouse | | X | X | | | |
| EBHH-15C | 1.5 - 2.5 | Greenhouse | | X | X | | | |
| EBHH-15D | 3 - 4 | Greenhouse | | X | X | | | |
| EBHH-16A | 0 - 0.5 | Greenhouse | X | X | | | | |
| EBHH-16B | 0.5 - 1.5 | Greenhouse | | X | | | | |
| EBHH-16C | 1.5 - 2.5 | Greenhouse | | X | | | | |
| EBHH-16D | 3 - 4 | Greenhouse | | X | | | | |
| EBHH-17A | 0 - 0.5 | Greenhouse | X | X | | | | |
| EBHH-17B | 0.5 - 1.5 | Greenhouse | | X | X | | | |
| EBHH-17C | 1.5 - 2.5 | Greenhouse | | X | X | | | |
| EBHH-17D | 3 - 4 | Greenhouse | | X | X | | | |
| EBHH-18A | 0 - 0.5 | Greenhouse/debris | X | X | | X | X | |
| EBHH-18B | 0.5 - 1.5 | Greenhouse/debris | | X | | (X) | (X) | |
| EBHH-18C | 1.5 - 2.5 | Greenhouse/debris | | X | | (X) | (X) | |
| EBHH-18D | 3 - 4 | Greenhouse/debris | | X | | (X) | (X) | |

| Sample Number | Depth (feet) | Designation/ Location | 600/R-93/116 for Asbestos | 6010B for RCRA Metals | 8081A for Pesticide | 8270C for PAHs | 8015M for TPH-d,o | 8260B for TPH-g/BTEX |
|---------------|--------------|-----------------------|---------------------------|-----------------------|---------------------|----------------|-------------------|----------------------|
| EBHH-19A | 0 - 0.5 | Greenhouse | X | X | | | | |
| EBHH-19B | 0.5 - 1.5 | Greenhouse | | X | X | | | |
| EBHH-19C | 1.5 - 2.5 | Greenhouse | | X | X | | | |
| EBHH-19D | 3 - 4 | Greenhouse | | X | X | | | |
| EBHH-20A | 0 - 0.5 | Greenhouse | X | X | | | | |
| EBHH-20B | 0.5 - 1.5 | Greenhouse | | X | | | | |
| EBHH-20C | 1.5 - 2.5 | Greenhouse | | X | | | | |
| EBHH-20D | 3 - 4 | Greenhouse | | X | | | | |
| EBHH-21A | 0 - 0.5 | Greenhouse | X | X | | | | |
| EBHH-21B | 0.5 - 1.5 | Greenhouse | | X | X | | | |
| EBHH-21C | 1.5 - 2.5 | Greenhouse | | X | X | | | |
| EBHH-21D | 3 - 4 | Greenhouse | | X | X | | | |
| EBHH-22A | 0 - 0.5 | Greenhouse/debris | X | X | | X | X | |
| EBHH-22B | 0.5 - 1.5 | Greenhouse/debris | | X | | (X) | (X) | |
| EBHH-22C | 1.5 - 2.5 | Greenhouse/debris | | X | | (X) | (X) | |
| EBHH-22D | 3 - 4 | Greenhouse/debris | | X | | (X) | (X) | |
| EBHH-23A | 0 - 0.5 | Greenhouse | X | X | | | | |
| EBHH-23B | 0.5 - 1.5 | Greenhouse | | X | X | | | |
| EBHH-23C | 1.5 - 2.5 | Greenhouse | | X | X | | | |
| EBHH-23D | 3 - 4 | Greenhouse | | X | X | | | |

| Sample Number | Depth (feet) | Designation/ Location | 600/R-93/116 for Asbestos | 6010B for RCRA Metals | 8081A for Pesticide | 8270C for PAHs | 8015M for TPH-d,o | 8260B for TPH-g/BTEX |
|---------------|--------------|-----------------------|---------------------------|-----------------------|---------------------|----------------|-------------------|----------------------|
| EBHH-24A | 0 - 0.5 | Greenhouse | X | X | | | | |
| EBHH-24B | 0.5 - 1.5 | Greenhouse | | X | | | | |
| EBHH-24C | 1.5 - 2.5 | Greenhouse | | X | | | | |
| EBHH-24D | 3 - 4 | Greenhouse | | X | | | | |
| EBHH-25A | 0 - 0.5 | Greenhouse/debris | X | X | | X | X | |
| EBHH-25B | 0.5 - 1.5 | Greenhouse/debris | | X | X | (X) | (X) | |
| EBHH-25C | 1.5 - 2.5 | Greenhouse/debris | | X | X | (X) | (X) | |
| EBHH-25D | 3 - 4 | Greenhouse/debris | | X | X | (X) | (X) | |
| EBHH-26A | 0 - 0.5 | Greenhouse/debris | X | X | | X | X | |
| EBHH-26B | 0.5 - 1.5 | Greenhouse/debris | | X | | (X) | (X) | |
| EBHH-26C | 1.5 - 2.5 | Greenhouse/debris | | X | | (X) | (X) | |
| EBHH-26D | 3 - 4 | Greenhouse/debris | | X | | (X) | (X) | |
| EBHH-27A | 0 - 0.5 | Greenhouse | X | X | | | | |
| EBHH-27B | 0.5 - 1.5 | Greenhouse | | X | X | | | |
| EBHH-27C | 1.5 - 2.5 | Greenhouse | | X | X | | | |
| EBHH-27D | 3 - 4 | Greenhouse | | X | X | | | |
| EBHH-28A | 0 - 0.5 | Greenhouse/debris | X | X | | X | X | |
| EBHH-28B | 0.5 - 1.5 | Greenhouse/debris | | X | | (X) | (X) | |
| EBHH-28C | 1.5 - 2.5 | Greenhouse/debris | | X | | (X) | (X) | |
| EBHH-28D | 3 - 4 | Greenhouse/debris | | X | | (X) | (X) | |

| Sample Number | Depth (feet) | Designation/ Location | 600/R-93/116 for Asbestos | 6010B for RCRA Metals | 8081A for Pesticide | 8270C for PAHs | 8015M for TPH-d,o | 8260B for TPH-g/BTEX |
|---------------|--------------|-----------------------|---------------------------|-----------------------|---------------------|----------------|-------------------|----------------------|
| EBHH-29A | 0 - 0.5 | Boiler room/debris | X | X | | X | X | |
| EBHH-29B | 0.5 - 1.5 | Boiler room/debris | | | | (X) | (X) | |
| EBHH-29C | 1.5 - 2.5 | Boiler room/debris | | | | (X) | (X) | |
| EBHH-29D | 3 - 4 | Boiler room/debris | | | | (X) | (X) | |
| EBHH-30A | 0 - 0.5 | Boiler room | | | | (X) | (X) | |
| EBHH-30B | 0.5 - 1.5 | Boiler room | | | | (X) | (X) | |
| EBHH-30C | 1.5 - 2.5 | Boiler room | | | | (X) | (X) | |
| EBHH-30D | 3 - 4 | Boiler room | | | | (X) | (X) | |
| EBHH-31A | 0 - 0.5 | Boiler room/debris | X | X | | X | X | |
| EBHH-31B | 0.5 - 1.5 | Boiler room/debris | | | | (X) | (X) | |
| EBHH-31C | 1.5 - 2.5 | Boiler room/debris | | | | (X) | (X) | |
| EBHH-31D | 3 - 4 | Boiler room/debris | | | | (X) | (X) | |
| EBHH-32A | 0 - 0.5 | Boiler room | | | | (X) | (X) | |
| EBHH-32B | 0.5 - 1.5 | Boiler room | | | | (X) | (X) | |
| EBHH-32C | 1.5 - 2.5 | Boiler room | | | | (X) | (X) | |
| EBHH-32D | 3 - 4 | Boiler room | | | | (X) | (X) | |
| EBHH-33A | 0 - 0.5 | Boiler room/debris | X | X | | X | X | |
| EBHH-33B | 0.5 - 1.5 | Boiler room/debris | | | | (X) | (X) | |
| EBHH-33C | 1.5 - 2.5 | Boiler room/debris | | | | (X) | (X) | |
| EBHH-33D | 3 - 4 | Boiler room/debris | | | | (X) | (X) | |

| Sample Number | Depth (feet) | Designation/ Location | 600/R-93/116 for Asbestos | 6010B for RCRA Metals | 8081A for Pesticide | 8270C for PAHs | 8015M for TPH-d,o | 8260B for TPH-g/BTEX |
|---------------|--------------|-----------------------|---------------------------|-----------------------|---------------------|----------------|-------------------|----------------------|
| EBHH-34A | 0 - 0.5 | Boiler room | | | | (X) | (X) | |
| EBHH-34B | 0.5 - 1.5 | Boiler room | | | | (X) | (X) | |
| EBHH-34C | 1.5 - 2.5 | Boiler room | | | | (X) | (X) | |
| EBHH-34D | 3 - 4 | Boiler room | | | | (X) | (X) | |
| EBHH-35A | 0 - 0.5 | Boiler room/debris | X | X | | X | X | |
| EBHH-35B | 0.5 - 1.5 | Boiler room/debris | | | | (X) | (X) | |
| EBHH-35C | 1.5 - 2.5 | Boiler room/debris | | | | (X) | (X) | |
| EBHH-35D | 3 - 4 | Boiler room/debris | | | | (X) | (X) | |
| EBHH-36A | 0 - 0.5 | Boiler room | | | | (X) | (X) | |
| EBHH-36B | 0.5 - 1.5 | Boiler room | | | | (X) | (X) | |
| EBHH-36C | 1.5 - 2.5 | Boiler room | | | | (X) | (X) | |
| EBHH-36D | 3 - 4 | Boiler room | | | | (X) | (X) | |
| EBHH-37A | 0 - 0.5 | Debris | X | X | | X | X | |
| EBHH-37B | 0.5 - 1.5 | Debris | | | | (X) | (X) | |
| EBHH-37C | 1.5 - 2.5 | Debris | | | | (X) | (X) | |
| EBHH-37D | 3 - 4 | Debris | | | | (X) | (X) | |
| EBHH-38A | 0 - 0.5 | Debris | | | | (X) | (X) | |
| EBHH-38B | 0.5 - 1.5 | Debris | | | | (X) | (X) | |
| EBHH-38C | 1.5 - 2.5 | Debris | | | | (X) | (X) | |
| EBHH-38D | 3 - 4 | Debris | | | | (X) | (X) | |

| Sample Number | Depth (feet) | Designation/ Location | 600/R-93/116 for Asbestos | 6010B for RCRA Metals | 8081A for Pesticide | 8270C for PAHs | 8015M for TPH-d,o | 8260B for TPH-g/BTEX |
|---------------|--------------|-----------------------|---------------------------|-----------------------|---------------------|----------------|-------------------|----------------------|
| EBHH-39A | 0 - 0.5 | Debris | X | X | | X | X | |
| EBHH-39B | 0.5 - 1.5 | Debris | | | | (X) | (X) | |
| EBHH-39C | 1.5 - 2.5 | Debris | | | | (X) | (X) | |
| EBHH-39D | 3 - 4 | Debris | | | | (X) | (X) | |
| EBHH-40A | 0 - 0.5 | Debris | | | | (X) | (X) | |
| EBHH-40B | 0.5 - 1.5 | Debris | | | | (X) | (X) | |
| EBHH-40C | 1.5 - 2.5 | Debris | | | | (X) | (X) | |
| EBHH-40D | 3 - 4 | Debris | | | | (X) | (X) | |
| EBHH-41A | 0 - 0.5 | Debris | X | X | | X | X | |
| EBHH-41B | 0.5 - 1.5 | Debris | | | | (X) | (X) | |
| EBHH-41C | 1.5 - 2.5 | Debris | | | | (X) | (X) | |
| EBHH-41D | 3 - 4 | Debris | | | | (X) | (X) | |
| EBHH-42A | 0 - 0.5 | Debris | | | | (X) | (X) | |
| EBHH-42B | 0.5 - 1.5 | Debris | | | | (X) | (X) | |
| EBHH-42C | 1.5 - 2.5 | Debris | | | | (X) | (X) | |
| EBHH-42D | 3 - 4 | Debris | | | | (X) | (X) | |
| EBHH-43A | 0 - 0.5 | Debris | X | X | | X | X | |
| EBHH-43B | 0.5 - 1.5 | Debris | | | | (X) | (X) | |
| EBHH-43C | 1.5 - 2.5 | Debris | | | | (X) | (X) | |
| EBHH-43D | 3 - 4 | Debris | | | | (X) | (X) | |

| Sample Number | Depth (feet) | Designation/ Location | 600/R-93/116 for Asbestos | 6010B for RCRA Metals | 8081A for Pesticide | 8270C for PAHs | 8015M for TPH-d,o | 8260B for TPH-g/BTEX |
|---------------|--------------|-----------------------|---------------------------|-----------------------|---------------------|----------------|-------------------|----------------------|
| EBHH-44A | 0 - 0.5 | Debris | | | | (X) | (X) | |
| EBHH-44B | 0.5 - 1.5 | Debris | | | | (X) | (X) | |
| EBHH-44C | 1.5 - 2.5 | Debris | | | | (X) | (X) | |
| EBHH-44D | 3 - 4 | Debris | | | | (X) | (X) | |
| EBHH-45A | 0 - 0.5 | Fuel tank | | | | | | |
| EBHH-45B | 0.5 - 1.5 | Fuel tank | | | | | (X) | (X) |
| EBHH-45C | 1.5 - 2.5 | Fuel tank | | | | | (X) | (X) |
| EBHH-45D | 3 - 4 | Fuel tank | | | | | (X) | (X) |
| EBHH-46A | 0 - 0.5 | Fuel tank | | | | | | |
| EBHH-46B | 0.5 - 1.5 | Fuel tank | | | | | (X) | (X) |
| EBHH-46C | 1.5 - 2.5 | Fuel tank | | | | | (X) | (X) |
| EBHH-46D | 3 - 4 | Fuel tank | | | | | (X) | (X) |
| EBHH-47A | 0 - 0.5 | Fuel tank | | | | | | |
| EBHH-47B | 0.5 - 1.5 | Fuel tank | | | | | (X) | (X) |
| EBHH-47C | 1.5 - 2.5 | Fuel tank | | | | | (X) | (X) |
| EBHH-47D | 3 - 4 | Fuel tank | | | | | (X) | (X) |
| EBHH-48A | 0 - 0.5 | Fuel tank | | | | | | |
| EBHH-48B | 0.5 - 1.5 | Fuel tank | | | | | (X) | (X) |
| EBHH-48C | 1.5 - 2.5 | Fuel tank | | | | | (X) | (X) |
| EBHH-48D | 3 - 4 | Fuel tank | | | | | (X) | (X) |

| Sample Number | Depth (feet) | Designation/ Location | 600/R-93/116 for Asbestos | 6010B for RCRA Metals | 8081A for Pesticide | 8270C for PAHs | 8015M for TPH-d,o | 8260B for TPH-g/BTEX |
|---------------|--------------|-----------------------|---------------------------|-----------------------|---------------------|----------------|-------------------|----------------------|
| EBHH-49A | 0 - 0.5 | Fuel tank/debris | X | X | | X | X | |
| EBHH-49B | 0.5 - 1.5 | Fuel tank/debris | | | | (X) | (X) | (X) |
| EBHH-49C | 1.5 - 2.5 | Fuel tank/debris | | | | (X) | (X) | (X) |
| EBHH-49D | 3 - 4 | Fuel tank/debris | | | | (X) | (X) | (X) |
| EBHH-50A | 0 - 0.5 | Fuel tank/debris | X | X | | X | X | |
| EBHH-50B | 0.5 - 1.5 | Fuel tank/debris | | | | (X) | (X) | (X) |
| EBHH-50C | 1.5 - 2.5 | Fuel tank/debris | | | | (X) | (X) | (X) |
| EBHH-50D | 3 - 4 | Fuel tank/debris | | | | (X) | (X) | (X) |
| EBHH-51A | 0 - 0.5 | Duplicate of EBHH-3A | X | X | | | | |
| EBHH-51B | 0.5 - 1.5 | Duplicate of EBHH-3B | | X | X | | | |
| EBHH-51C | 1.5 - 2.5 | Duplicate of EBHH-3C | | X | X | | | |
| EBHH-52A | 0 - 0.5 | Duplicate of EBHH-13A | X | X | | | | |
| EBHH-52B | 0.5 - 1.5 | Duplicate of EBHH-13B | | X | X | | | |
| EBHH-52C | 1.5 - 2.5 | Duplicate of EBHH-13C | | X | X | | | |
| EBHH-53A | 0 - 0.5 | Duplicate of EBHH-23A | X | X | | | | |

| Sample Number | Depth (feet) | Designation/ Location | 600/R-93/116 for Asbestos | 6010B for RCRA Metals | 8081A for Pesticide | 8270C for PAHs | 8015M for TPH-d,o | 8260B for TPH-g/BTEX |
|--|--------------|-----------------------|--|------------------------|-----------------------|--|-------------------|----------------------|
| EBHH-53B | 0.5 - 1.5 | Duplicate of EBHH-23B | | X | X | | | |
| EBHH-54B | 0.5 - 1.5 | Duplicate of EBHH-27A | X | X | | | | |
| EBHH-54B | 1.5-2.5 | Duplicate of EBHH-27B | | X | | | | |
| EBHH-55A | 0.5 - 1.5 | Duplicate of EBHH-33A | | X | | X | X | |
| EBHH-56A | 0.5 - 1.5 | Duplicate of EBHH-43A | | X | | X | X | |
| EBHH-57A | 0.5 - 1.5 | Duplicate of EBHH-50A | | X | | | | |
| EBHH-58x | TBD | Duplicate of TBD | | | | X | X | X |
| EBHH-59x | TBD | Duplicate of TBD | | | | X | X | X |
| EBHH-60x | TBD | Duplicate of TBD | | | | X | X | X |
| Number of Field Samples: | | | 38 | 122 ¹ | 42 ¹ | 42 ² | 46 | 4 ² |
| Number of Duplicates: | | | 4 | 13 | 5 | 5 | 5 | 1 |
| Number of Samples as MS/MSDs*: | | | na | 7 | 3 | 2 | 2 | 1 |
| TOTAL NUMBER OF SAMPLES: | | | 42 | 119¹ | 47¹ | 47² | 51 | 5² |
| ¹ = Represents the total possible amount of samples. Samples collected at the 3-4 ft bgs interval will have the option of being analyzed. ² = Represents the total number of samples collected. Approximately 10 percent (or 7 samples) will be shipped to the laboratory for analysis. | | | * = MS/MSD sample locations (approximately 20 percent) will be determined in the field, based on the number of samples that will be shipped to the laboratory. (X) = Field screening of samples will determine laboratory analyses. | | | PAHs = Polynuclear Aromatic Hydrocarbons TPH-d,o = Total Petroleum Hydrocarbons as diesel, oil TPH-g = Total Petroleum Hydrocarbons as gasoline BTEX = Benzene, Toluene, Ethyl benzene, total Xylenes MS/MSD = Matrix Spike/Matrix Spike Duplicate TBD = To Be Determined PLM = Polarized Light Microscopy | | |

**Table 5-2: Request for Analytical Services
Matrix - Groundwater**

| Method Number & Analysis | 6010B for RCRA Metals | 8081A for Pesticide | 8270C SIMS for PAHs | 8260B for VOCs | 8015M for TPH-d,o | 8260B for TPH-g/BTEX | | |
|----------------------------------|--------------------------------------|------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------|----------------------|
| Preservatives | HNO ₃ pH<2 & Chill to 4 C | Chill to 4 C | Chill to 4 C | HCl pH<2 & Chill to 4 C | Chill to 4 C | HCl pH<2 & Chill to 4 C | | |
| Analytical Holding Time | 6 months 28 days Hg | 7 days Extract. 40 days Analyze | 14 days Extract. 40 days Analyze | 14 days Extract. 40 days Analyze | 14 days Extract. 40 days Analyze | 14 days Extract. 40 days Analyze | | |
| Sample Volume / Sample Container | 1 x 1 L Polyethylene bottle | 2 x 1 L Amber Glass | 2 x 1 L Amber Glass | 2 x 40 mL VOA vial Glass | 2 x 1 L Amber Glass | 2 x 40 mL VOA vial Glass | | |
| Sample Information: | | | | | | | | |
| Sample Number | Depth (feet) | Location/Designation | 6010B for RCRA Metals | 8081A for Pesticide | 8270C SIMS for PAHs | 8060B for VOCs | 8015M for TPH-d,o | 8260B for TPH-g/BTEX |
| EBHH-GW-1 | 20 | downgradient of plating shop | X | | | X | | |
| EBHH-GW-2 | 20 | boiler rooms | | | X | | X | |
| EBHH-GW-3 | 20 | fuel tank | | | | | X | X |
| EBHH-GW-4 | 20 | downgradient of site | X | X | X | X | X | X |
| EBHH-GW-5 | 20 | Duplicate of EBHH-GW-4 MS/MSD | X | X | X | X | X | X |
| EBHH-EB-1 | N/A | Equipment Blank Soil Sampler Day 1 | X | X | X | | X | |
| EBHH-EB-2 | N/A | Equipment Blank Soil Sampler Day 2 | X | X | X | | X | |
| EBHH-EB-3 | N/A | Equipment Blank Soil Sampler Day 3 | X | X | X | | X | X |

| Sample Number | Depth (feet) | Location/Designation | 6010B for RCRA Metals | 8081A for Pesticide | 8270C SIMS for PAHs | 8060B for VOCs | 8015M for TPH-d,o | 8260B for TPH-g/BTEX |
|--|--------------|--|-----------------------|---------------------|---------------------|----------------|-------------------|----------------------|
| EBHH-EB-4 | N/A | Equipment Blank Expendable drive point holder | X | X | X | X | X | X |
| Number of Field Samples: | | | 2 | 1 | 2 | 2 | 3 | 2 |
| Number of Trip/Equip. Blanks: | | | 4 | 4 | 4 | 2 | 4 | 2 |
| Number of Field Duplicates: | | | 1 | 1 | 1 | 1 | 1 | 1 |
| Number of Samples as MS/MSDs: | | | 1 | 1 | 1 | 1 | 1 | 1 |
| TOTAL NUMBER OF SAMPLES | | | 7 | 6 | 7 | 5 | 8 | 5 |
| PAHs = Polynuclear Aromatic Hydrocarbons TPH-d,o = Total Petroleum Hydrocarbons as Diesel, Oil TPH-g = Total Petroleum Hydrocarbons as gasoline BTEX = Benzene, Toluene, Ethyl benzene, total Xylenes MS/MSD = Matrix Spike/Matrix Spike Duplicate | | | | | | | | |

6.0 METHODS AND PROCEDURES

6.1 Field Equipment

6.1.1 Sampling Equipment

The following equipment will be used to obtain environmental samples:

| Equipment | Fabrication | Dedicated |
|---|--------------------|------------------|
| Macro-Core® Sampler | Hardened Steel | No |
| Macro-Core® Sampler Sleeves | Acetate | Yes |
| Expendable Drive Point Holder (for well screen installation) | Hardened Steel | No |
| 0.75-inch Well Screen | PVC | Yes |
| Peristaltic Pump Tubing | HDPE | Yes |
| 6-ounce Scoops | Plastic | Yes |
| Gloves | Nitrile | Yes |
| Zip-lock Bags | Plastic | Yes |

The planned equipment will be operated in accordance with EPA Environmental Response Team (ERT) Standard Operating Procedure (SOP) #2050 Geoprobe® Operation, SOP #2012 Soil Sampling, SOP #2007 Groundwater Well Sampling, and SOP #2006 Sampling Equipment and Decontamination. Copies of these SOPs are contained in Appendix E.

6.1.2 Inspection/Acceptance Requirements for Supplies and Consumables

There are no project-specific inspection/acceptance criteria for supplies and consumables. It is standard operating procedure that personnel will not use broken or defective materials; items will not be used past their expiration date; supplies and consumables will be checked against order and packing slips to verify the correct items were received; and the supplier will be notified of any missing or damaged items.

6.2 Sampling Procedures

The anticipated sample locations are presented in Figure 4-1, but if indicators such as stained soil are apparent, judgmental sampling will be used to target areas of suspected contamination. Exact sampling locations will be determined in the field based on accessibility, visible signs of

potential contamination (e.g., stained soils), and topographical features that may indicate the location of a hazardous substance. Actual sample locations will be recorded using a GPS and entered into the field logbook as sampling is completed.

6.2.1 Soil Sampling

As shown in Figure 4-1, soil samples will be collected from 50 locations. WESTON will collect soil samples from a combination of surface and subsurface depths. All soil will be collected in accordance with ERT SOPs #2012 and #2050.

The surface soil samples will be collected at a depth interval of surface to 0.5 feet bgs. WESTON will collect subsurface soil samples using a direct-push rig with a Macro-Core[®] sampler. Subsurface soil samples will be collected at the following depth intervals: 0.5 to 1.5 feet bgs; 1.5 to 2.5 feet bgs; and 3 to 4 feet bgs. Samples will be collected and transferred directly into a pre-labeled sample container using a dedicated plastic trowel. Samples to be analyzed for TPH-g and BTEX will be collected in 5 gram En Core[®] Sampler containers. Sample containers will be closed as soon as they are filled, chilled immediately to 4°C, and processed for shipment to the laboratory.

6.2.2 Groundwater Sampling

As shown in Figure 4-1, groundwater samples will be collected from four locations. WESTON will collect the groundwater samples following ERT SOPs 2012 and 2050.

Groundwater samples will be collected from four temporary 0.75- inch polyvinyl chloride (PVC) wells installed with a direct-push rig. The temporary wells will be installed after driving 1.5- inch diameter drive rods fitted with an expendable point to 24 feet bgs. A PVC well screen with a threaded end cap and PVC riser will be inserted into the drive rods. The expendable point will be deployed as the drive rod is withdrawn, leaving the temporary well screen in place. Groundwater samples will be collected by lowering dedicated high density polyethylene (HDPE) tubing to 6 to 12 inches above the bottom of the temporary well; the other end of the tubing will be attached to a peristaltic pump. Sample containers will be closed as soon as they are filled, chilled to 4°C, and processed for shipment to the laboratory. Groundwater samples collected for RCRA metals analysis will be filtered in the field with a 0.45 micron filter. WESTON will record the water level measurements at the time of sampling.

6.3 Decontamination Procedures

The decontamination procedures that will be followed are in accordance with approved procedures. Decontamination of sampling equipment must be conducted consistently to assure the quality of samples collected. All non-dedicated equipment that comes into contact with potentially contaminated water, soil, and/or sediment will be decontaminated. Disposable equipment intended for one-time use will not be decontaminated, but will be packaged for

appropriate disposal. Decontamination will occur prior to and after each use of a piece of non-dedicated equipment. Non-dedicated equipment requiring decontamination includes the following: drilling equipment, water level tape, surge block, and submersible pump. All non-dedicated sampling devices used will be steam-cleaned or decontaminated in accordance to ERT SOP #2006.

The following, to be carried out in sequence, is the EPA Region 9 recommended procedure for the decontamination of sampling equipment:

- Hot water pressure wash
- Non-phosphate detergent and tap water wash, using a brush if necessary
- Tap-water rinse
- Isopropanol alcohol rinse
- Deionized/distilled water rinse (twice)

Equipment will be decontaminated in a predesignated area on pallets or plastic sheeting, and clean bulky equipment will be stored on plastic sheeting in uncontaminated areas. Cleaned small equipment will be stored in plastic bags. Materials to be stored more than a few hours will also be covered.

6.4 Borehole Abandonment Procedures

Soil borings will be backfilled with neat cement grout after the completion of sampling activities. Minimal soil cuttings will be generated as most of the 4-foot soil core will be submitted to the laboratory. Soil not submitted to the laboratory will be returned to the boring from which it originated, prior to backfilling with grout.

Temporary groundwater wells will be abandoned by first removing the PVC screen and casing and then backfilling the borings with neat cement grout using a tremie pipe.

7.0 DISPOSAL OF INVESTIGATION-DERIVED WASTE

In the process of collecting environmental samples at the site, several different types of potentially contaminated investigation-derived wastes (IDW) will be generated, including the following:

- Used personal protective equipment (PPE)
- Disposable sampling equipment
- Soil cuttings
- Decontamination fluids

The EPA's National Contingency Plan (NCP) requires that management of IDW generated during sampling comply with all relevant and appropriate requirements to the extent practicable. This sampling plan will follow the *Office of Emergency and Remedial Response (OERR) Directive 9345.3-02* (May 1991), which provides the guidance for management of IDW. In addition, other legal and practical considerations that may affect the handling of IDW will be considered. Listed below are the procedures that will be followed for handling IDW. The procedures are flexible enough to allow the sampling team to use its professional judgement on the proper method for the disposal of each type of IDW generated at each sampling location.

- Used PPE and disposable sampling equipment will be double-bagged in plastic trash bags and disposed of in a municipal refuse dumpster. These wastes are not considered hazardous and can be sent to a municipal landfill. Any PPE or dedicated equipment that is to be disposed of that can still be reused will be rendered inoperable before disposal.
- Soil cuttings generated will consist of the portion of soil core not submitted to the laboratory for analysis. The small volume of soil not submitted to the laboratory will be returned to the boring from which it originated.
- Decontamination fluids that will be generated in the sampling event will consist of dilute isopropanol/methanol, deionized water, residual contaminants, and water with non-phosphate detergent. The volume and concentration of the decontamination fluid will be sufficiently low to allow disposal at the site or sampling area. The decontamination fluids will be discharged to the ground.

8.0 SAMPLE IDENTIFICATION, DOCUMENTATION AND SHIPMENT

8.1 Field Notes

8.1.1 Field Logbooks

Field logbooks will document where, when, how, and from whom any vital project information was obtained. Logbook entries will be complete and accurate enough to permit reconstruction of field activities. The logbook is bound with consecutively numbered pages. Each page will be dated and the time of entry noted in military time. All entries will be legible, written in ink, and signed by the individual making the entries. Language will be factual, objective, and free of personal opinions. At a minimum, the following information will be recorded, if applicable, during the collection of each sample:

- Sample location and description
- Sampler's name(s)
- Date and time of sample collection
- Type of sample (e.g., groundwater)
- Type of sampling equipment used
- Field instrument readings and calibration readings for any equipment used, and equipment model(s) and serial number(s)
- Field observations and details related to analysis or integrity of samples (e.g., weather conditions, noticeable odors, colors, etc.)
- Sample preservation
- Lot numbers of the sample containers, sample identification numbers and any explanatory codes, and chain-of-custody form numbers
- Shipping arrangements (overnight air bill number)
- Name(s) of recipient laboratory(ies)

In addition to sampling information, the following specifics may also be recorded in the field logbook for each day of sampling:

- Team members and their responsibilities
- Time of arrival on site and time of site departure
- Other personnel on site
- Summary of any meetings or discussions with any potentially responsible parties, or representatives of any federal, state, or other regulatory agency
- Deviations from sampling plans or site safety plan procedures
- Changes in personnel and responsibilities, as well as reasons for the change
- Levels of safety protection
- Record of photographs

8.1.2 Photographs

Photographs will be taken at representative sampling locations and at other areas of interest on site. They will verify information entered in the field logbook. When a photograph is taken, the following information will be written on the logbook or will be recorded in a separate field photography log:

- Time, date, location, and weather conditions
- Description of the subject photographed
- Name of person taking the photograph

8.2 Sample Nomenclature

As shown in Table 5-1 and Table 5-2 a unique, identifiable name will be assigned to each sample. The prefix “EBHH” will be used to identify the East Bay Habitat for Humanity, 10800 Edes Avenue site. The suffix will identify the borehole number. If the matrix is soil, an “A” following the borehole location number will represent the shallowest sample depth, “B”, “C”, and “D” will designate the increasingly deeper samples, with “D” being the deepest. For example, the name EBHH-2B signifies the sample was collected from Borehole 2, the sample matrix is soil, and the sample was collected at sample depth interval 0.5 to 1.5 feet bgs. Groundwater samples will be identified the same way, with the exception that the suffix “GW”, will be substituted for the soil/sample depth notation (i.e., EBHH-GW-1 indicates a groundwater sample). Equipment blank samples will be labeled using the suffix “EB” followed by a number to designate the equipment type and day it was collected. Duplicate samples will be assigned fictitious names.

8.3 Container, Preservation, and Holding Time Requirements

All sample containers used will have been delivered to WESTON in a pre-cleaned condition. Container, preservation, and technical holding time requirements are summarized in Table 5-1 and Table 5-2. Soil samples for TPH-g and BTEX analyses will be collected using an En Core® Sampler following EPA Method 5035. Sample containers will be preserved in the field with nitric acid for metal analysis and hydrochloric acid for VOCs, and, TPH-g/BTEX analyses. The appropriate acid will be added to the bottle incrementally while counting the number of drops until the desired pH is achieved. The PH will be checked by pouring a small volume of groundwater from the container over litmus paper; the number of drops of acid will be recorded in the field logbook. The subsequent bottles will be preserved with the same quantity of acid.

8.4 Sample Labeling, Packaging and Shipping

All samples collected will be labeled in a clear and precise way for proper identification in the field and for tracking in the laboratory. Sample labels will be created using the Forms II Lite data management system. Sample labels will be affixed to the sample containers and secured with clear tape. Samples will have preassigned, identifiable, and unique numbers in accordance with Section 8.1. The sample labels will contain the following information where appropriate:

- Sample number
- Sample location
- Date and time of collection
- Site name
- Analytical parameter and method of preservation

Samples will be stored on ice in a secure location pending shipment to the contract laboratory. Sample coolers will be retained in the custody of site personnel at all times or secured so as to deny access to anyone else. The procedures for shipping samples are as follows:

- Ice will be packed in double zip-locked plastic bags
- The drain plug of the cooler will be taped shut to prevent leakage
- The bottom of the cooler will be lined with bubble wrap to prevent breakage during shipment
- Screw caps will be checked for tightness
- Containers will have custody seals affixed so as to prevent opening of the container without breaking the seal
- All glass sample containers will be wrapped in bubble wrap.
- All containers will be sealed in zip-lock plastic bags

All samples will be placed in coolers with the appropriate chain-of-custody forms. All forms will be enclosed in plastic bags and affixed to the underside of the cooler lid. Bags of ice will be placed on top of and around samples. Empty space in the cooler will be filled with bubble wrap or styrofoam peanuts to prevent movement and breakage during shipment. Absorbent material will also be placed in the cooler to absorb spills that occur. Each ice chest will be securely taped shut with strapping tape, and custody seals will be affixed to the front, right, and back of each cooler. Samples will be shipped for immediate delivery to the laboratory.

8.5 Chain of Custody Forms and QA/QC Summary Forms

A chain-of-custody form will be maintained for all samples to be submitted for analysis, from the time the sample is collected until its final deposition. Every transfer of custody must be

noted and signed for; a copy of this record is kept by each individual who has signed.

Corrections on sample paperwork will be made by drawing a single line through the mistake and initialing and dating the change. The correct information will be entered above, below, or after the mistake. When samples are not under the direct control of the individual responsible for them, they must be stored in a locked container sealed with a custody seal. The chain-of-custody must include the following:

- Sample identification numbers
- Site name
- Sample date
- Number and volume of sample containers
- Required analyses
- Signature and name of samplers
- Signature(s) of any individual(s) with control over samples
- Airbill number
- Note(s) indicating special holding times and/or detection limits

9.0 QUALITY ASSURANCE AND CONTROL (QA/QC)

9.1 Field Quality Control Samples

The QA/QC samples described in the following subsections, which are also listed in Table 5-1 and Table 5-2 will be collected during this investigation.

9.1.1 Assessment of Field Contamination (Blanks)

9.1.1.1 Equipment Blanks

For any day of the sampling event that is conducted using only dedicated disposable equipment, no equipment blanks will be collected. During each day that non-dedicated equipment will be used in the collection of soil or groundwater samples, one equipment blank will be collected. The equipment blank will be collected by pouring High Performance Liquid Chromatograph (HPLC)-grade water over the piece of non-dedicated equipment into a sample bottle. The equipment blanks will be analyzed according to Table 5-2.

The equipment blanks will be preserved, packaged, and sealed in the manner described for the groundwater samples in Section 6.2. A separate sample number will be assigned to each sample and it will be submitted blind to the laboratory.

9.1.1.2 Temperature Blanks

For each cooler that is shipped or transported to an analytical laboratory, a 40-milliliter vial, or equivalent, of deionized water will be included that is marked “temperature blank.” This blank will be used by the sample custodian to check the temperature of samples upon receipt.

9.1.2 Assessment of Sample Variability (Field Duplicate Samples)

Duplicate soil samples will be collected for 10 percent of the field samples (one per 10 samples per matrix) from locations indicated in Table 5-1 and one duplicate groundwater sample will be collected at the one sample location indicated in Table 5-2. These locations have been selected because they are expected to have detectable concentrations of AOCs, based on the site history.

Duplicate samples will be preserved, packaged, and sealed in the same manner described for the groundwater samples in Section 6.2. A separate sample number will be assigned to each duplicate, and it will be submitted blind to the laboratory.

9.2 Laboratory Quality Control Samples

A laboratory QC sample, called MS for inorganic analyses and MS/MSD for organic analyses, is not an extra sample; rather, it is a sample that requires additional QC analysis.

For soil samples, double-volume soil samples will be collected at nine assigned location to ensure that sufficient volume is collected for both routine sample analysis and additional laboratory QC analysis. Soil samples to be analyzed for metals will be homogenized in a sample-dedicated zip-lock bag. Homogenized material will then be transferred to 4-ounce glass jars and labeled with the sample number.

For groundwater samples, a double-volume groundwater sample will be collected at one assigned location to ensure that sufficient volume is collected for both routine sample analysis and additional laboratory QC analysis. Two sets of water sample containers are filled and all containers are labeled with a single sample number.

For this sampling event, the samples designated for laboratory QC samples will be chosen in the field due to the large portion of samples selected for analyses based on field screening. The sample labels and chain-of-custody records for these samples will identify them as laboratory QC samples. At a minimum, one sample per 20 samples, per matrix, will be designated as a laboratory QC sample.

9.3 Analytical and Data Package Requirements

It is required that all samples be analyzed in accordance with the methods listed in Tables 5-1 and 5-2. The laboratory is required to supply documentation to demonstrate that their data meet the requirements specified in the contract.

The data validation package shall include all original documentation generated in support of this project. In addition, the laboratory will provide original documentation to support that all requirements of the method have been met. This includes, but is not limited to, sample tags, custody records, shipping information, sample preparation/extraction records, and instrument printouts such as mass spectra. Copies of information and documentation required in this document are acceptable. The following deliverables are required. Note that the following data requirements are included to specify and emphasize general documentation requirements and are not intended to supersede or change requirements of the specific method.

- Copy of the chain-of-custody, sample log-in records, and a Case Narrative describing the analyses and methods used and discussing the presence of any interferences, the criteria used to identify tentatively identified compounds (TICs), and the failure of the lab to meet any of the requirements or re-analyses.

- Analytical data (results) up to 3 significant figures for all samples, method blanks, MS/MSD, Laboratory Control Samples (LCS), duplicates, and field QC samples
- QC summary sheets that summarize the following:
 1. MS/MSD/LCS recovery summary
 2. Method/preparation blank summary
 3. Initial and continuing calibration summary (including retention time windows)
 4. Sample holding time and analytical sequence (i.e., extraction and analysis)
 5. Calibration curves and correlation coefficients
 6. Duplicate summary
 7. Detection limit information
- Analyst bench records describing dilution, weighing of samples, percent moisture (solids), sample size, sample extraction and cleanup, final extract volumes and amount injected.
- Detailed explanation of the Quantitation and identification procedure used for specific analyses, giving examples of calculations from the raw data
- The final deliverable report will consist of sequentially numbered pages
- Internal/surrogate recoveries
- Gas Chromatograph/Mass Spectrometer tuning conditions
- Reconstructed ion current chromatogram and quantitation reports for all sample standards, blanks, MS/MSD, and performance evaluation samples
- For every compound identified and each field sample, provide raw versus enhanced spectra and enhanced versus reference spectra
- For target analytes, the reference spectrum shall be the check standard for that sample; for TICs, the reference mass spectrum shall be the best fit spectrum from a search of the spectral library
- Confirmation analysis data - second column confirmation required for all TICs; provide all associated raw data and summary sheets for the confirmation analyses

9.4 Data Validation

Data validation of analytical data generated by the laboratory will be performed by WESTON in accordance with the *EPA Contract Laboratory Program National Functional Guidelines for Organic Data Review*. Tier 1 validation for 100 percent of the data will be required.

To meet requirements for categorization as definitive data, the following criteria must be evaluated:

- Holding times
- Sampling design approach

- Blank combination
- Initial and continuing calibration
- Detection limits
- Analyte identification and quantitation
- Matrix spike recoveries
- Performance evaluation samples when specified
- Analytical and total error determination
- LCSs

Upon completion of validation, data will be classified as one of the following: acceptable for use without qualifications, acceptable for use with qualifications, or unacceptable for use.

9.5 Field Variances

As conditions in the field may vary, it may become necessary to implement minor modifications to this plan. When appropriate, the EPA TM will be notified of the modifications and a verbal approval will be obtained before implementing the modifications. Modifications to the original plan will be documented in the final report.

9.6 Assessment of Project Activities

9.6.1 WESTON Assessment Activities

The following assessment activities will be performed by WESTON:

- All project deliverables (SAP, Data Summaries, Data Validation Reports, Investigation Report) will be peer reviewed prior to release to the EPA. In time-critical situations, the peer review may be concurrent with the release of a draft document to the EPA. Errors discovered in the peer review process will be reported by the reviewer to the originator of the document, who will be responsible for corrective action.
- The PM will review project documentation (logbooks, chain of custody forms, etc.) to ensure the SAP was followed and that sampling activities were adequately documented. The PM will document deficiencies and will be responsible for corrective actions.

9.6.2 EPA Assessment Activities

EPA assessment activities, which can include surveillance, management system reviews, readiness reviews, technical system audits, performance evaluation, and audits and assessments of data quality, have not been formally identified to WESTON by the EPA at the time of completion of the SAP.

9.6.3 Project Status Reports to Management

It is standard procedure for the WESTON PM to report to the EPA TM any issues, as they occur, that arise during the course of the project that could affect data quality, data use objectives, the project objectives, or project schedules.

9.6.4 Reconciliation of Data with DQOs

Assessment of data quality is an ongoing activity throughout all phases of a project. The following outlines the methods to be used by WESTON for evaluating the results obtained from the project.

- Review of the DQO outputs and the sampling design will be conducted by the WESTON PM and the EPA QAO prior to sampling activities. The QAO reviewer will submit comments to the WESTON PM for action, comment, or clarification. This process will be iterative.
- A preliminary data review will be conducted by WESTON. The purpose of this review is to look for problems or anomalies in the implementation of the sample collection and analysis procedures and to examine QC data for information to verify assumptions underlying the DQOs and the SAP.
- When appropriate to sample design, basic statistical quantities will be calculated and the data will be graphically represented.
- When appropriate to the sample design and if specifically tasked to do so by the EPA TM, WESTON will select a statistical hypothesis test and identify assumptions underlying the test.
- When appropriate to the sample design and if specifically tasked to do so by the EPA TM, WESTON will examine the underlying assumptions of the statistical hypothesis test in light of the environmental data. This will be accomplished by determining the approach for verifying assumptions, performing tests for assumptions, and determining corrective actions.

**APPENDIX A
DATA QUALITY
OBJECTIVE WORKSHEET**

Data Quality Objective Process Worksheet

1. **State the Problem** - Summarize the contamination problem that will require new environmental data, and identify the resources available to resolve the problem.

Planning Team:

Susanne Perkins USEPA

Teresita Salire, USACE

Michael Chao, East Bay Habitat for Humanity

Joe De Fao, Weston Solutions, Inc.

Tom Fortner, Weston Solutions, Inc.

Susanne Perkins of the USEPA is the primary decision maker of the scoping team.

Problem:

The East Bay Habitat for Humanity 10800 Edes Avenue (EBHH) site is a 1.7 acre area in Oakland, California. Currently, the property owners operate a construction and demolition business on site. From the mid to late 1900s, several greenhouses were located on the property. It is suspected that one or two broiler rooms and a gasoline or fuel tank were located on the property.

EBHH has received an EPA Brownfields Assessment Grant to investigate the site that may be purchased for a residential housing development. A Phase I investigation has been conducted for this property; however, it is unavailable for review at this time. Currently, no sampling and analysis has been performed to determine the presence or absence of contamination in soil or groundwater from past operations.

Soil and groundwater sampling in the vicinity of the site will be required to document the presence of hazardous materials in site soils, and to document an observed release to groundwater.

Available Resources:

Current budget not to exceed approximately \$55,949; use of WESTON personnel; subcontracted laboratory; subcontracted drilling personnel. All work and reporting should be completed by January 23, 2006. Preliminary data will be available two weeks after fieldwork.

2. **Identify the Decision** - Identify the decision that requires new environmental data to

address the contamination problem.

Data will be used to assess whether contaminants are present in site soils and/or groundwater at concentrations that would pose a danger to human health based on the planned site reuse as a residential housing development.

Principal Study Questions:

- a) Is soil and/or groundwater contamination present at the site at levels that exceed appropriate action levels based on the intended reuse?

Define the alternative actions that could result from the resolution of the principal study question:

- a) Soil and/or groundwater are not impacted. Redevelopment may begin.
- b) Soil and/or groundwater contaminant concentrations are above action levels protective of human health and/or groundwater. Remedial actions may be required to make the site suitable for planned redevelopment activity, or the planned site redevelopment may be reconfigured.

Decision Statement:

If soil and/or groundwater contamination is found in excess of action levels protective of human health and/or groundwater, then options for further site characterization, remediation, or alternative uses of the site will be considered.

- 3. **Identify Inputs to the Decision** - Identify the information needed to support the decision, and specify which inputs require new environmental data.

Information required to resolve the decision statement: Definitive data from chemical analysis of soil and groundwater samples are required. Based on a review of the available site history, the goal of the sampling will be to collect and analyze soil and groundwater for possible site contaminants such as: asbestos, metals, organochlorine pesticides, polynuclear aromatic hydrocarbons (PAHs), total petroleum hydrocarbons as diesel and motor oil (TPH-d,o) and total petroleum hydrocarbons as gasoline (TPH-g).

Source(s) for information: The primary source of information will be the results of WESTON's groundwater and soil sampling event. Another potential source could include prior site investigation reports. In addition, city, state, and county agencies may have information pertaining to the site .

Information needed to establish action levels: For soil - USEPA Region 9 Preliminary Remediation Goals (PRGs) for residential soils. For groundwater - USEPA Maximum Contaminant Levels (MCLs).

Confirm that measurement methods exist to provide data:

Soils:

- EPA Test Method 01A0007115 for Asbestos
- EPA Method 6010 for RCRA Metals
- EPA Method 8081A for Organochlorine Pesticides
- EPA Method 8310 for PAHs
- EPA Method 8015 for TPH-d,o and TPH-g

Groundwater:

- EPA Method 6010 for RCRA Metals
- EPA Method 8081A for Organochlorine Pesticides
- EPA Method 8310 for PAHs

- 4. Define the Study Boundaries** - Specify the spatial and temporal aspects of the environmental media that the data must represent to support the decision.

Specific characteristics that define population being studied: Elevated concentrations of asbestos, metals, pesticides, PAHs, TPH-d,o, and TPH-g in soil and elevated concentrations of metals, pesticides, and PAHs in groundwater.

Spatial boundary of decision statement: The boundaries of the 1.7-acre site from the surface soils to the shallow groundwater.

Temporal boundary of decision statement: The data will represent the conditions of contaminants at the time of sampling and into the foreseeable future.

When to collect samples: Samples will be collected within 5 weeks of the DQO scoping meeting.

Practical constraints on data collection: Currently there are no existing monitoring wells on-site or downgradient of the site.

- 5. Develop a Decision Rule** - Develop logical “if...then” statements that define the conditions that would cause the decision maker to choose among alternative actions.

Statistical parameter that characterizes a population: Each analytical result, not statistical parameter, will be evaluated against the action levels.

Specify the action level(s) for the study: For soil - USEPA Region 9 PRGs for residential soils. For groundwater - USEPA MCLs.

Decision Rules:

- f) If concentrations in soil samples are above USEPA Region 9 PRGs for residential

soils, then additional characterization, remedial actions, or reconfiguration of future site uses may be required.

- b) If concentrations in groundwater samples are above MCLs, then future uses of groundwater at the site may be limited or a reconfiguration of future site uses may be required.

6. Specify the Limits on Decision Errors - Specify the decision makers acceptable limits on decision errors, which are used to establish performance goals for limiting uncertainty in the data.

Use of biased sampling points precludes statistical determination of limits on decision errors. Measurement error, rather than sampling error, is deemed to be the primary factor affecting any decision error. Validated, definitive data will be required to limit measurement error. Sampling error will be limited to the extent practicable by following approved USEPA methods and applicable SOPs. Sampling error and tolerable limits cannot be quantified.

7. Optimize the Design for Obtaining Data - Identify the most resource-effective sampling and analysis design for generating data that are expected to satisfy the DQOs.

The goals of the sampling event are to establish whether soil and/or groundwater at the site are contaminated with hazardous materials. Soil samples will be collected at various locations throughout the site that have been identified as potential sources of contamination. Soil samples will be analyzed for asbestos, metals, pesticides, PAHs, TPH-d,o and/or TPH-g. Four groundwater samples will be collected; one in each of the property corners, and analyzed for metals, pesticides, and PAHs.

**APPENDIX B
SITE SPECIFIC
HEALTH AND SAFETY PLAN**

SITE HEALTH AND SAFETY PLAN (HASP)-FORM 1

Prepared by: Amanda K. Cohan

W.O. Number: 12676.061.003

Date: October 11, 2005

Project Identification

Office: Walnut Creek, CA
 Site Name: East Bay Habitat for Humanity, 10800 Edes Avenue (EBHH)
 Client: USACE/USEPA
 Work Location Address: 10800 Edes Avenue
 Oakland, CA

Site History:

The EBHH site is a 1.7 acre area in Oakland, California. Currently, the property owners operate a construction and demolition business on site. From the mid to late 1900s, several greenhouses were located on the property. It is suspected that one or two boiler rooms and a gasoline or fuel tank were located on the property. EBHH has received an EPA Brownfields Assessment Grant to investigate the site that may be purchased for a residential housing development.

Scope of Work:

Drill 50 soil borings to a maximum depth of 4.5 feet using a direct-push rig and collect 200 soil samples. In addition, a Hydropunch will be used to advance 4 borings to a depth at which groundwater is first encountered, which is anticipated to be approximately 10 feet bgs. Groundwater samples will be analyzed for metals, pesticides and polynuclear aromatic hydrocarbons (PAHs). Soil samples will be analyzed for asbestos, metals, pesticides, PAHs, total petroleum hydrocarbons as diesel and motor oil (TPH-d,o) and/or total petroleum hydrocarbons as gasoline (TPH-g).

☐ Site visit only; site HASP not necessary. List personnel here and sign off below:

Regulatory Status:

Site regulatory status:

**CERCLA/SARA
Federal Agency**

RCRA

Other

☒ U.S. EPA ☐ U.S. EPA ☐ DOE
☐ State ☐ State ☒ USACE
☐ NPL Site **NRC** ☐ Air Force
☐ OSHA ☐ 10 CFR 20 ☐ _____
☐ Hazard Communication (Req'd See Attachment D)
☐ 1910 ☐ 1926 ☐ State

X Safety Officer Manual (Required to be On-Site)

Based on the Hazard Assessment and Regulatory Status, determine the Standard HASP(s) applicable to this project. Indicate below which Standard HASP will be used and append the appropriate pages of this form along with the Standard Plan.

☐ Stack Test ☐ _____
☐ Air Emissions ☐ _____
☐ Asbestos ☐ _____
☐ Industrial Hygiene ☐ _____
☐ _____ ☐ _____

Review and Approval Documentation:

Reviewed by:

SO/DSM/CHS

Michelle Zehr

Name (Print)

Signature

Date: _____

Approved by:

Project Manager

Thomas Fortner

Name (Print)

Signature

Date: _____

Hazard Assessment and Equipment Selection:

In accordance with WESTON's Personal Protective Equipment Program and 29 CFR 1910.132, at the site prior to personnel beginning work, the SHSC and/or the Site Manager have evaluated conditions and verified that the personal protective equipment selection outlined within this HASP is appropriate for the hazards known or expected to exist. (Refer to Safety Officer Manual Section 2, Personal Protection Program, for guidance.)

☐ SHSC ☒ Site Manager Tom Fortner Date: _____
 Name (Print) Signature

Project start date: 11/14/2005

End date: 11/18/2005

This site HASP **must be reissued/reapproved** for any activities conducted after:

Date: 11/14/06

Amendment date(s) By:

1.
2.
3.
4.

WESTON REPRESENTATIVES FORM 2

| Organization/Branch | Name/Title | Address | Telephone |
|------------------------|---|--|----------------|
| WESTON/Seattle | Frank Monahan Program Manager | 190 Queen Anne Ave, North Suite 200 Seattle, WA 98109-4927 | (206) 521-7600 |
| WESTON/Walnut Creek | Joe De Fao Project Manager/ Field Sampling QC Coordinator | 1575 Treat Blvd., Suite 212 Walnut Creek, CA 94598 | (925) 948-2657 |
| WESTON/Walnut Creek | Tom Fortner Field Manager | 1575 Treat Blvd., Suite 212 Walnut Creek, CA 94598 | (925) 948-2655 |
| WESTON/Sherman Oaks | Michelle Zehr Health and Safety Officer | 1575 Treat Blvd., Suite 212 Walnut Creek, CA 94598 | (925) 948-2655 |

Roles and Responsibilities: The Project Manager is responsible for management of the site investigation work assignment. The Field Sampling QC Coordinator is responsible for making sure that field QC requirements are met during the sampling event. The Field Manager is responsible for completion of technical and field activities associated with this site investigation

WESTON SUBCONTRACTORS

| Organization/Branch | Name/Title | Address | Telephone |
|---------------------|------------|---------|-----------|
|---------------------|------------|---------|-----------|

To be determined.

Roles and Responsibilities: Operate the hollow stem auger for soil and groundwater sampling, under WESTON direction.

SITE-SPECIFIC HEALTH AND SAFETY PERSONNEL

The Site Health and Safety Coordinator (SHSC) for activities to be conducted at this site is: Tom Fortner

The SHSC has total responsibility for ensuring that the provisions of this Site HASP are adequate and implemented in the field.

Changing field conditions may require decisions to be made concerning adequate protection programs. Therefore, the personnel assigned as SHSCs are experienced and meet the additional training requirements specified by OSHA in 29 CFR 1910.120.

Qualifications: 40-Hour HAZWOPER, current 8-Hour HAZWOPER Refresher, SHSC (D), First Aid, CPR, BBP

Designated alternates include: Mindy Smith

The Dangerous Goods Shipper for activities to be conducted at this site is: _____

☒ Dangerous Goods Shipping not required for this site because only environmental samples will be shipped.

Qualifications:

Designated alternates include:

The Environmental Compliance Officer (ECO) for activities to be conducted at this site is:

The ECO has total responsibility for ensuring that the provisions of the Site EC Plan are adequate and implemented in the field.

Qualifications: Hazardous Waste Management & Shipping for Environmental Professionals

Designated alternates include:

HEALTH AND SAFETY EVALUATION FORM 3

Hazard Assessment

Background Review: ☐ Complete ☒ Partial

If partial why? Groundwater an soil sampling has not been conducted at this site; therefore, background contaminants have not been identified. The HASP will be amended to include hazards noted during the field activities.

Activities Covered Under This Plan:

| No. | Task/Subtask | Description | Schedule |
|-----|---|--|--|
| 1 | Borings will be drilled and groundwater will be sampled | Four borings will be advanced to a depth at which groundwater is first encountered (approximately 20 feet bgs) and groundwater will be collected if encountered. | Tentatively beginning week of November 7, 2005 |
| 2 | Borings will be drilled and soil will be sampled | 50 borings will be advanced to 4 feet bgs and soil samples at descending depths will be collected at each location. | Tentatively beginning week of November 7, 2005 |

Types of Hazards:

1 and 2 Numbers refer to one of the following hazard evaluation forms. Complete hazard evaluation forms for each appropriate hazard class.

| | | | |
|---|--|--|--|
| Physiochemical 1 <input type="checkbox"/> Flammable <input type="checkbox"/> Explosive <input type="checkbox"/> Corrosive <input type="checkbox"/> Reactive <input type="checkbox"/> O ₂ Rich <input type="checkbox"/> O ₂ Deficient | Chemically Toxic 1 <input checked="" type="checkbox"/> Inhalation <input type="checkbox"/> Carcinogen <input checked="" type="checkbox"/> Ingestion <input type="checkbox"/> Mutagen <input checked="" type="checkbox"/> Contact <input type="checkbox"/> Teratogen <input checked="" type="checkbox"/> Absorption <input type="checkbox"/> OSHA 1910.1000 Substance (Air Contaminants) <input checked="" type="checkbox"/> OSHA Specific Hazard Substance Standard (Refer to following page for listing) | Radiation 3 Ionizing: <input type="checkbox"/> Internal exposure <input type="checkbox"/> External exposure Non-ionizing: <input checked="" type="checkbox"/> UV <input type="checkbox"/> IR <input type="checkbox"/> RF <input type="checkbox"/> MicroW <input type="checkbox"/> Laser | Biological 2 <input type="checkbox"/> Etiological Agent <input checked="" type="checkbox"/> Other (plant, insect, animal) <input checked="" type="checkbox"/> Physical Hazards 4 <input checked="" type="checkbox"/> Construction Activities |
|---|--|--|--|

Source/Location of Contaminants and Hazardous Substances:

| | |
|--|--|
| Directly Related to Tasks <input type="checkbox"/> Air <input type="checkbox"/> Other Surface <input checked="" type="checkbox"/> Groundwater <input checked="" type="checkbox"/> Soil <input type="checkbox"/> Surface Water <input type="checkbox"/> Sanitary Wastewater <input type="checkbox"/> Process Wastewater <input type="checkbox"/> Other | Indirectly Related to Tasks — Nearby Process(es) That Could Affect Team Members: <input type="checkbox"/> Client Facility/WESTON Work Location <input type="checkbox"/> Nearby Non-Client Facility Describe: <input type="checkbox"/> Have activities (task[s]) been coordinated with facility? |
|--|--|

HEALTH AND SAFETY EVALUATION—CHEMICAL HAZARDS OF CONCERN-FORM 4 (REVISED 02/1998)

☐ N/A

Chemical Contaminants of Concern

Provide the data requested for chemical contaminants on HASP Form 25 or attach data sheets from an acceptable source such as NIOSH pocket guide, condensed chemical dictionary, ACGIH TLV booklet, etc. List chemicals and concentrations below and locate data sheets in Attachment B of this HASP.

☐ N/A

Identify hazardous materials used or on-site and attach Material Safety Data Sheets (MSDSs) for all reagent type chemicals, solutions, or other identified materials that in normal use in performing tasks related to this project could produce hazardous substances. Ensure that all subcontractors and other parties working nearby are informed of the presence of these chemicals and the location of the MSDSs. Obtain from subcontractors and other parties, lists of the hazardous materials they use or have on-site and identify location of the MSDSs here. List chemicals and quantities below and locate MSDSs in Attachment B of this HASP.

| Chemical Name | Concentration (if known) | Chemical Name | Quantity |
|-------------------|-----------------------------|--|--|
| Metals | Unknown | Isobutylene in air (compound) | 100 ppm x 0.5 Kg |
| Pesticides | Unknown | Hydrochloric acid, nitric acid (preservatives) | Approximately 12 preserved containers |
| PAHs | Unknown | Alconox | Approximately 1 gallon |
| TPH-d,o and TPH-g | Unknown | | |
| Asbestos | Unknown | | |
| BTEX, HVOCs | Unknown | | |

OSHA-SPECIFIC HAZARDOUS SUBSTANCES

The following substances may require specific medical, training, or monitoring based on concentration or evaluation of risk. See the appropriate citation listed under 29 CFR 1910 or 1926 for additional information.

- | | | | |
|--|--|---|--|
| <input checked="" type="checkbox"/> 1910.1001 Asbestos | <input checked="" type="checkbox"/> 1910.1002 Coal tar pitch volatiles | <input type="checkbox"/> 1910.1003 4-Nitrobiphenyl, etc. | <input type="checkbox"/> 1910.1004 alpha-Naphthylamine |
| <input type="checkbox"/> 1910.1005 [Reserved] | <input type="checkbox"/> 1910.1006 Methyl chloromethyl ether | <input type="checkbox"/> 1910.1007 3,3'-Dichlorobenzidine (and its salts) | <input type="checkbox"/> 1910.1008 bis-Chloromethyl ether |
| <input type="checkbox"/> 1910.1009 beta-Naphthylamine | <input type="checkbox"/> 1910.1010 Benzidine | <input type="checkbox"/> 1910.1011 4-Aminodiphenyl | <input type="checkbox"/> 1910.1012 Ethyleneimine |
| <input type="checkbox"/> 1910.1013 beta-Propiolactone | <input type="checkbox"/> 1910.1014 2-Acetylaminofluorene | <input type="checkbox"/> 1910.1015 4-Dimethylaminobenzene | <input type="checkbox"/> 1910.1016 N-Nitrosodimethylamine |
| <input type="checkbox"/> 1910.1017 Vinyl chloride | <input type="checkbox"/> 1910.1018 Inorganic arsenic | <input checked="" type="checkbox"/> 1910.1025 Lead (Att. FLD# 46) | <input checked="" type="checkbox"/> 1910.1027 Cadmium |
| <input checked="" type="checkbox"/> 1910.1028 Benzene | <input type="checkbox"/> 1910.1029 Coke oven emissions | <input type="checkbox"/> 1910.1043 Cotton dust | <input type="checkbox"/> 1910.1044 1,2-Dibromo-3-chloropropane |
| <input type="checkbox"/> 1910.1045 Acrylonitrile | <input type="checkbox"/> 1910.1047 Ethylene oxide | <input type="checkbox"/> 1910.1048 Formaldehyde | <input type="checkbox"/> 1910.1050 Methyleneedianiline |
| <input type="checkbox"/> 1910.1051 1,3 Butadiene | <input type="checkbox"/> 1910.1052 Methylene chloride | | |

HEALTH AND SAFETY EVALUATION — 2 BIOLOGICAL HAZARDS OF CONCERN-FORM 5

☐ **Poisonous Plants (FLD 43)**

Location/Task No(s).:

Source: ☐ Known ☐ Suspect

Route of Exposure: ☐ Inhalation ☐ Ingestion
☐ Contact ☐ Direct Penetration

Team Member(s) Allergic: ☐ Yes ☐ No

Immunization required: ☐ Yes ☐ No

☒ **Insects (FLD 43)**

Location/Task No(s).:

Source: ☐ Known ☒ Suspect

Route of Exposure: ☐ Inhalation ☐ Ingestion
☒ Contact ☒ Direct Penetration

Team Member(s) Allergic: ☐ Yes ☒ No

Immunization required: ☐ Yes ☒ No

☐ **Snakes, Reptiles (FLD 43)**

Location/Task No(s).:

Source: ☐ Known ☐ Suspect

Route of Exposure: ☐ Inhalation ☐ Ingestion
☐ Contact ☐ Direct Penetration

Team Member(s) Allergic: ☐ Yes ☐ No

Immunization required: ☐ Yes ☐ No

☐ **Animals (FLD 43)**

Location/Task No(s).:

Source: ☐ Known ☐ Suspect

Route of Exposure: ☐ Inhalation ☐ Ingestion
☐ Contact ☐ Direct Penetration

Team Member(s) Allergic: ☐ Yes ☐ No

Immunization required: ☐ Yes ☐ No

FLD 43 — WESTON Biohazard Field Operating Procedures: Att. OP ☐

☐ **Sewage**

Location/Task No(s).:

Source: ☐ Known ☐ Suspect

Route of Exposure: ☐ Inhalation ☐ Ingestion
☐ Contact ☐ Direct Penetration

Team Member(s) Allergic: ☐ Yes ☐ No

Immunization required: ☐ Yes ☐ No

Tetanus Vaccination within Past 10 yrs: ☐ Yes ☐ No

☐ **Etiologic Agents (List)**

Location/Task No(s).:

Source: ☐ Known ☐ Suspect

Route of Exposure: ☐ Inhalation ☐ Ingestion
☐ Contact ☐ Direct Penetration

Team Member(s) Allergic: ☐ Yes ☐ No

Immunization required: ☐ Yes ☐ No

FLD 44 — WESTON Bloodborne Pathogens Exposure Control Plan – First Aid Procedures: Att. OP ☒

FLD 45 — WESTON Bloodborne Pathogens Exposure Control Plan – Working with Infectious Waste: Att. OP ☐

HEALTH AND SAFETY EVALUATION — 3 RADIATION HAZARDS OF CONCERN-FORM 6 (REVISED 02/1998)

NONIONIZING RADIATION

| Task No. | Type of Nonionizing Radiation | Source On-Site | TLV/PEL | Wavelength Range | Control Measures | Monitoring Instrument |
|----------|-------------------------------|----------------|---------|------------------|--------------------------|-----------------------|
| 1,2 | Ultraviolet | Sun | | | Sunscreen, stay hydrated | |
| N/A | Infrared | | | | | |
| N/A | Radio Frequency | | | | | |
| N/A | Microwave | | | | | |
| N/A | Laser | | | | | |

IONIZING RADIATION

| Task No. | Radionuclide | Major Radiations | Radioactive Half-Life (Years) | DAC ($\mu\text{Ci}/\text{mL}$) | | | Surface Contamination Limit | Monitoring Instrument |
|----------|--------------|------------------|-------------------------------|----------------------------------|---|---|-----------------------------|-----------------------|
| | | | | D | W | Y | | |
| | | | | | | | | |

HEALTH AND SAFETY EVALUATION — 4 PHYSICAL HAZARDS OF CONCERN-FORM 7

| Phy. Haz. Cond. | Physical Hazard | Attach OP | WESTON OP Titles |
|----------------------------|--|-------------------------------------|---|
| Loud noise | Hearing loss/disruption of communication | <input checked="" type="checkbox"/> | FLD01 - Noise Protection |
| Inclement weather | Rain/humidity/cold/ice/snow/lightning | <input type="checkbox"/> | FLD02 - Inclement Weather |
| Steam heat stress | Burns/displaced oxygen/wet working surfaces | <input type="checkbox"/> | FLD03 - Hot Process - Steam |
| Heat stress | Burns/hot surfaces/low pressure steam | <input type="checkbox"/> | FLD04 - Hot Process - LT3 |
| Ambient heat stress | Heat rash/cramps/exhaustion/heat stroke | <input type="checkbox"/> | FLD05 - Heat Stress Prevention/Monitoring |
| Cold stress | Hypothermia/frostbite | <input type="checkbox"/> | FLD06 - Cold Stress |
| Cold/wet | Trench/paddy/immersion foot/edema | <input type="checkbox"/> | FLD07 - Wet Feet |
| Confined spaces | Falls/burns/drowning/engulfment/electrocution | <input type="checkbox"/> | FLD08 - Confined Space Entry |
| Explosive vapors | Thermal burns/impaction/dismemberment | <input type="checkbox"/> | FLD09 - Hot Work |
| Improper lifting | Back strain/abdomen/arm/leg muscle/joint injury | <input checked="" type="checkbox"/> | FLD10 - Manual Lifting/Handling Heavy Objects |
| Uneven surfaces | Vehicle accidents/slips/trips/falls | <input checked="" type="checkbox"/> | FLD11 - Rough Terrain |
| Poor housekeeping | Slips/trips/falls/punctures/cuts/fires | <input checked="" type="checkbox"/> | FLD12 - Housekeeping |
| Structural integrity | Crushing/overhead hazards/compromised floors | <input type="checkbox"/> | FLD13 - Structural Integrity |
| Hostile persons | Bodily injury | <input checked="" type="checkbox"/> | FLD14 - Site Security |
| Remote area | Slips/trips/falls/back strain/communication | <input type="checkbox"/> | FLD15 - Remote Area |
| Improper cyl. handling | Mechanical injury/fire/explosion/suffocation | <input type="checkbox"/> | FLD16 - Pressure Systems - Compressed Gases |
| Water hazards | Poor visibility/entanglement/drowning/cold stress | <input type="checkbox"/> | FLD17 - Diving |
| Water hazards | Drowning/heat/cold stress/hypothermia/falls | <input type="checkbox"/> | FLD18 - Operation and Use of Boats |
| Water hazards | Drowning/frostbite/hypothermia/falls/electrocution | <input type="checkbox"/> | FLD19 - Working Over Water |
| Vehicle hazards | Struck by vehicle/collision | <input type="checkbox"/> | FLD20 - Traffic |
| Explosions | Explosion/fire/thermal burns | <input type="checkbox"/> | FLD21 - Explosives |
| Moving mechanical parts | Crushing/pinch points/overhead hazards/electrocution | <input checked="" type="checkbox"/> | FLD22 - Heavy Equipment Operation |
| Moving mech. parts | Overhead hazards/electrocution | <input type="checkbox"/> | FLD23 - Cranes/Lifting Equipment Operation |
| Working at elevation | Overhead hazards/falls/electrocution | <input type="checkbox"/> | FLD24 - Aerial Lifts/Manlifts |
| Working at elevation | Overhead hazards/falls/electrocution | <input type="checkbox"/> | FLD25 - Working at Elevation |
| Working at elevation | Overhead hazards/falls/electrocution/slips | <input type="checkbox"/> | FLD26 - Ladders |
| Working at elevation | Slips/trips/falls/overhead hazards | <input type="checkbox"/> | FLD27 - Scaffolding |
| Trench cave-in | Crushing/falling/overhead hazards/suffocation | <input type="checkbox"/> | FLD28 - Excavating/Trenching |
| Improper material handling | Back injury/crushing from load shifts | <input type="checkbox"/> | FLD29 - Materials Handling |
| Physiochemical | Explosions/fires from oxidizing, flam./corr. material | <input type="checkbox"/> | FLD30 - Hazardous Materials Use/Storage |
| Physiochemical | Fire and explosion | <input type="checkbox"/> | FLD31 - Fire Prevention/Response Plan Required |
| Physiochemical | Fire | <input type="checkbox"/> | FLD32 - Fire Extinguishers Required |
| Structural integrity | Overhead/electrocution/slips/trips/falls/fire | <input type="checkbox"/> | FLD33 - Demolition |
| Electrical | Electrocution/shock/thermal burns | <input checked="" type="checkbox"/> | FLD34 - Utilities |
| Electrical | Electrocution/shock/thermal burns | <input type="checkbox"/> | FLD35 - Electrical Safety |
| Burns/fires | Heat stress/fires/burns | <input type="checkbox"/> | FLD36 - Welding/Cutting/Burning |
| Impact/thermal | Thermal burns/high pressure impaction/heat stress | <input type="checkbox"/> | FLD37 - High Pressure Washers |
| Impaction/electrical | Smashing body parts/pinching/cuts/electrocution | <input checked="" type="checkbox"/> | FLD38 - Hand and Power Tools |
| Poor visibility | Slips/trips/falls | <input type="checkbox"/> | FLD39 - Illumination |
| Fire/explosion | Burns/impaction | <input type="checkbox"/> | FLD40 - Storage Tank Removal/Decommissioning |
| Communications | Disruption of communications | <input type="checkbox"/> | FLD41 - Std. Hand/Emergency Signals |
| Energy/release | Unexpected release of energy | <input type="checkbox"/> | FLD42 - Lockout/Tagout |
| General field work | Insects, plants, animals, snakes, reptiles (Haz. Eval. Form 2) | <input checked="" type="checkbox"/> | FLD43 - Biological Hazards |
| Providing first aid | HBV, HIV (Haz. Eval. Form 2) | <input checked="" type="checkbox"/> | FLD44 - BBP for First Aid Providers |
| Handling infectious waste | HBV, HIV (Haz. Eval. Form 2) | <input type="checkbox"/> | FLD45 - BBP for Infectious Waste |
| Lead contaminated sites | Lead poisoning | <input checked="" type="checkbox"/> | FLD46 - Control of Exposure to Lead |
| Puncture/cuts | Cuts/dismemberment/gouges | <input type="checkbox"/> | FLD47 - Clearing, Grubbing and Logging Operations |
| Not applicable | Not applicable | <input checked="" type="checkbox"/> | FLD48 - OSHA Inspections |
| Drilling hazards | Electrocution/overhead hazards/pinch points | <input checked="" type="checkbox"/> | 2.5 - Drilling Safety Guide |

**TASK-BY-TASK RISK ASSESSMENT-FORM 8
(COMPLETE ONE SHEET FOR EACH TASK)**

TASK DESCRIPTION

TASK 1 –Advance four borings using direct-push rig and conduct groundwater sampling.

EQUIPMENT REQUIRED/USED

(Be specific, e.g., hand tools, heavy equipment, instruments, PPE)

| | | |
|-------------------------|-----------------|-------------------|
| Hard hat | First Aid Kit | Sample coolers |
| Safety Boots | PID | Sample Containers |
| Hearing Protection | Direct Push Rig | Zip-Lock Bags |
| Protective Glasses | Hand Auger | Trash Bags |
| Nitrile Surgical Gloves | Paper Towels | |

POTENTIAL HAZARDS/RISKS

Chemical

☒ Hazard Present Risk Level: ☐ H ☒ M ☐ L

What justifies risk level? Potential risk of exposure to metals, pesticides, PAHs in groundwater. Contaminant concentrations expected to be low to medium in groundwater. No respiratory hazard anticipated. Use of nitrile gloves and good housekeeping protocols will minimize contact or absorption with potentially contaminated groundwater.

Physical

☒ Hazard Present Risk Level: ☐ H ☒ M ☐ L

What justifies risk level? Potential hazards include being struck by drilling equipment and tripping/falling. Maintain eye contact with drilling equipment and other heavy equipment operators when working near them.

Biological

☒ Hazard Present Risk Level: ☐ H ☐ M ☒ L

What justifies risk level? Insects, such as spiders, may be present at work locations. Use of gloves and general awareness will be implemented.

RADIOLOGICAL

☐ Hazard Present Risk Level: ☐ H ☐ M ☒ L

What justifies risk level? Given the time of year and work location, sun exposure is expected. Use of sunscreen and consumption of fluids will be implemented during field activities.

LEVELS OF PROTECTION/JUSTIFICATION

Level D, since no air pathway hazards are known or suspected in the breathing zone. If elevated monitoring instrument readings are observed, the team will withdraw immediately and reassess the situation.

SAFETY PROCEDURES REQUIRED AND/OR FIELD OPS UTILIZED

All field activities will be performed in accordance with this HASP and WESTON's standard operating procedures outlined in WESTON's Safety Officer Field Manual.

FDL01, FLD10, FLD11, FLD12, FLD14, FLD22, FLD34, FLD38, FLD43, FLD44, FLD46, FLD48, and 2.5

**TASK-BY-TASK RISK ASSESSMENT FORM 8
(COMPLETE ONE SHEET FOR EACH TASK)**

TASK DESCRIPTION

TASK 2 –Advance 58 borings using a direct-push rig to conduct soil sampling.

EQUIPMENT REQUIRED/USED

(Be specific, e.g., hand tools, heavy equipment, instruments, PPE)

| | | |
|-------------------------|-----------------|-------------------|
| Hard hat | First Aid Kit | Sample coolers |
| Safety Boots | PID | Sample Containers |
| Hearing Protection | Direct Push Rig | Zip-Lock Bags |
| Protective Glasses | Hand Auger | Trash Bags |
| Nitrile Surgical Gloves | Paper Towels | |

POTENTIAL HAZARDS/RISKS

Chemical

☒ Hazard Present Risk Level: ☐ H ☒ M ☐ L

What justifies risk level? Potential risk of exposure to asbestos, metals, pesticides, PAHs, TPH-d,o, and TPH-g in soil. Contaminant concentrations expected to be low to medium in soil. No respiratory hazard anticipated. Use of nitrile gloves and good housekeeping protocols will minimize contact or absorption with soil potentially contaminated with metals and/or VOCs.

Physical

☒ Hazard Present Risk Level: ☐ H ☒ M ☐ L

What justifies risk level? Potential hazards include being struck by drilling equipment and tripping/falling. Maintain eye contact with drilling equipment and other heavy equipment operators when working near them.

Biological

☒ Hazard Present Risk Level: ☐ H ☐ M ☒ L

What justifies risk level? Insects, such as spiders, may be present at work locations. Use of gloves and general awareness will be implemented.

RADIOLOGICAL

☐ Hazard Present Risk Level: ☐ H ☐ M ☒ L

What justifies risk level? Given the time of year and work location, sun exposure is expected. Use of sunscreen and consumption of fluids will be implemented during field activities.

LEVELS OF PROTECTION/JUSTIFICATION

Level D, since no air pathway hazards are known or suspected in the breathing zone. If elevated monitoring instrument readings are observed, the team will withdraw immediately and reassess the situation.

SAFETY PROCEDURES REQUIRED AND/OR FIELD OPS UTILIZED

All field activities will be performed in accordance with this HASP and WESTON's standard operating procedures outlined in WESTON's Safety Officer Field Manual.

FDL01, FLD10, FLD11, FLD12, FLD14, FLD22, FLD34, FLD38, FLD43, FLD44, FLD46, FLD48, and 2.5

PERSONNEL PROTECTION PLAN-FORM 9 (REVISED 02/1998)

Engineering Controls

Describe Engineering Controls used as part of Personnel Protection Plan:

Task(s)

1,2 Air monitoring will be performed at each sampling location. Situate workers on upwind side of boring wherever possible.

Administrative Controls

Describe Administrative Controls used as part of Personnel Protection Plan:

Task(s)

1,2 An initial health and safety tailgate meeting will be held at the site before work commences. Work will be completed in accordance with this HASP under the supervision/guidance of the SHSC.

Personal Protective Equipment

Action Levels for Changing Levels of Protection. Refer to HASP Form 13, Site Air Monitoring Program—Action Levels. Define Action Levels for up or down grade for each task:

Task(s)

1,2 Level D. PID in breathing zone; 50 ppm or less above background—continue to work in Level D. Consistent PID readings in breathing zone greater than 50 ppm above background that do not dissipate—stop work. Although PID readings greater than 50 ppm are not anticipated, the breathing zone action guidance document will be implemented if PID detects over 50 ppm.

DESCRIPTION OF LEVELS OF PROTECTION

| Level D | | Level D Modified | |
|---|------------------------------------|--|--|
| Task(s): All | | Task(s): All | |
| <input checked="" type="checkbox"/> Head | Hard Hat | <input type="checkbox"/> Head | |
| <input checked="" type="checkbox"/> Eye and Face | Safety glasses | <input type="checkbox"/> Eye and Face | |
| <input checked="" type="checkbox"/> Hearing | Earplugs as necessary | <input type="checkbox"/> Hearing | |
| <input type="checkbox"/> Arms and Legs Only | | <input type="checkbox"/> Arms and Legs Only | |
| <input type="checkbox"/> Appropriate Work Uniform | Coveralls, or appropriate clothing | <input type="checkbox"/> Whole Body | |
| <input checked="" type="checkbox"/> Hand - Gloves | Nitrile | <input type="checkbox"/> Apron | |
| <input checked="" type="checkbox"/> Foot - Safety Boots | Steel Toe | <input type="checkbox"/> Hand - Gloves | |
| <input type="checkbox"/> Fall Protection | | <input type="checkbox"/> Gloves | |
| <input type="checkbox"/> Flotation | | <input type="checkbox"/> Foot - Safety Boots | |
| <input type="checkbox"/> Other | | <input type="checkbox"/> Over Boots | |

DESCRIPTION OF LEVELS OF PROTECTION-FORM 10

| Level C | Level B |
|--|---|
| Task(s): All <input type="checkbox"/> Head <input type="checkbox"/> Eye and Face <input type="checkbox"/> Hearing <input type="checkbox"/> Arms and Legs Only <input type="checkbox"/> Whole Body <input type="checkbox"/> Apron <input type="checkbox"/> Hand - Gloves <input type="checkbox"/> Gloves <input type="checkbox"/> Gloves <input type="checkbox"/> Foot - Safety Boots <input type="checkbox"/> Outer Boots <input type="checkbox"/> Boots (Other) <input type="checkbox"/> Half Face <input type="checkbox"/> Cart./Canister <input type="checkbox"/> Full Face <input type="checkbox"/> Cart./Canister <input type="checkbox"/> PAPR <input type="checkbox"/> Cart./Canister <input type="checkbox"/> Type C <input type="checkbox"/> Fall Protection <input type="checkbox"/> Flotation <input type="checkbox"/> Other | Task(s): <input type="checkbox"/> Head <input type="checkbox"/> Eye and Face <input type="checkbox"/> Hearing <input type="checkbox"/> Arms and Legs Only <input type="checkbox"/> Whole Body <input type="checkbox"/> Apron <input type="checkbox"/> Hand - Gloves <input type="checkbox"/> Gloves <input type="checkbox"/> Gloves <input type="checkbox"/> Foot - Safety Boots <input type="checkbox"/> Outer Boots <input type="checkbox"/> Boots (Other) <input type="checkbox"/> SAR - Airline <input type="checkbox"/> SCBA <input type="checkbox"/> Comb. Airline/SCBA <input type="checkbox"/> Cascade System <input type="checkbox"/> Compressor <input type="checkbox"/> Fall Protection <input type="checkbox"/> Flotation <input type="checkbox"/> Other |

SITE OR PROJECT HAZARD MONITORING PROGRAM-FORM 11

Air Monitoring Instruments

Instrument Selection and Initial Check Record

Reporting Format: ☒ Field Notebook ☐ Field Data Sheets* ☐ Air Monitoring Log ☐ Trip Report ☐ Other

| Instrument | Task No.(s) | Number Required | Number Received | Checked Upon Receipt | Comment | Initials |
|---|-------------|-----------------|-----------------|--------------------------|---------|----------|
| <input type="checkbox"/> CGI | | | | <input type="checkbox"/> | | |
| <input type="checkbox"/> O ₂ | | | | <input type="checkbox"/> | | |
| <input type="checkbox"/> CGI/O ₂ | | | | <input type="checkbox"/> | | |
| <input type="checkbox"/> CGI/O ₂ /tox-PPM, H ₂ S, H ₂ S/CO | | | | <input type="checkbox"/> | | |
| <input type="checkbox"/> RAD | | | | <input type="checkbox"/> | | |
| <input type="checkbox"/> GM (Pancake) | | | | <input type="checkbox"/> | | |
| <input type="checkbox"/> NaI (Micro R) | | | | <input type="checkbox"/> | | |
| <input type="checkbox"/> ZnS (Alpha Scintillator) | | | | <input type="checkbox"/> | | |
| <input type="checkbox"/> Other _____ | | | | <input type="checkbox"/> | | |
| <input checked="" type="checkbox"/> PID | 1,2 | | | <input type="checkbox"/> | | |
| <input type="checkbox"/> HNu 10.2 | | | | <input type="checkbox"/> | | |
| <input type="checkbox"/> HNu 11.7 | | | | <input type="checkbox"/> | | |
| <input type="checkbox"/> Photovac, TMA | | | | <input type="checkbox"/> | | |
| <input type="checkbox"/> OVM | | | | <input type="checkbox"/> | | |
| <input type="checkbox"/> Other _____ | | | | <input type="checkbox"/> | | |
| <input checked="" type="checkbox"/> FID | 1,2 | | | <input type="checkbox"/> | | |
| <input type="checkbox"/> Fox 128 | | | | <input type="checkbox"/> | | |
| <input type="checkbox"/> Heath, AID, Other | | | | <input type="checkbox"/> | | |
| <input type="checkbox"/> RAM, Mini-RAM, Other _____ | | | | <input type="checkbox"/> | | |
| <input type="checkbox"/> Monitox | | | | <input type="checkbox"/> | | |
| Specify: _____ | | | | <input type="checkbox"/> | | |
| <input type="checkbox"/> Personal Sampling | | | | <input type="checkbox"/> | | |
| Specify: _____ | | | | <input type="checkbox"/> | | |
| <input type="checkbox"/> Bio-Aerosol Monitor | | | | <input type="checkbox"/> | | |
| <input type="checkbox"/> Pump - MSA, Dräger, Sensidyne | | | | <input type="checkbox"/> | | |
| <input type="checkbox"/> Tubes/type: _____ | | | | <input type="checkbox"/> | | |
| <input type="checkbox"/> Tubes/type: _____ | | | | <input type="checkbox"/> | | |
| <input type="checkbox"/> Other _____ | | | | <input type="checkbox"/> | | |

*Refer to Attachment E.

[illegible]

SITE AIR MONITORING PROGRAM-FORM 13

Action Levels

These Action Levels, if not defined by regulation, are some percent (usually 50%) of the applicable PEL/TLV/REL. That number must also be adjusted to account for instrument response factors.

| | Tasks | Action Level | | Action |
|---|-------|--|-------------------------------|--|
| <input type="checkbox"/> Explosive atmosphere | | Ambient Air Concentration | Confined Space Concentration | |
| | | <10% LEL | 0 to 1% LEL | Work may continue. Consider toxicity potential. |
| | | 10 to 25% LEL | 1 to 10% LEL | Work may continue. Increase monitoring frequency. |
| | | >25% LEL | >10% LEL | Work must stop. Ventilate area before returning. |
| <input type="checkbox"/> Oxygen | | Ambient Air Concentration | Confined Space Concentration | |
| | | <19.5% O ₂ | <19.5% O ₂ | Leave area. Re-enter only with self-contained breathing apparatus. |
| | | 19.5% to 25% O ₂ | 19.5% to 23.5% O ₂ | Work may continue. Investigate changes from 21%. |
| | | >25% O ₂ | >23.5% O ₂ | Work must stop. Ventilate area before returning. |
| <input type="checkbox"/> Radiation | | < 3 times background 3 times background to < 1 mR/hour > 1 mrem/hour | | Continue work. Radiation above background levels (normally 0.01-0.02 mR/hr) signifies possible radiation source(s) present. Continue investigation with caution. Perform thorough monitoring. Consult with a Health Physicist. Potential radiation hazard. Evacuate site. Continue investigation only upon the advice of Health Physicist. |
| <input checked="" type="checkbox"/> Organic gases and vapors | 1,2 | PID readings in breathing zone (BZ) ≤1 ppm unit above background. PID readings in BZ consistently > 50 ppm unit above background that do not dissipate. Although PID readings greater than 50 ppm are not anticipated, the breathing zone action guidance document will be implemented if PID detects over 50 ppm. | | Continue working in Level D. Cease work. |
| <input checked="" type="checkbox"/> Inorganic gases, vapors, and particulates | 1,2 | Negligible visible dust. Visible dust that does not dissipate. | | Continue working in Level D. Cease work. |

CONTINGENCIES-FORM 14

Emergency Contacts and Phone Numbers

| Agency | Contact | Phone Number |
|--|-----------------------------|----------------|
| Local Medical Emergency Facility (LMF) | Community Hospital | (323) 268-5514 |
| WESTON Medical Emergency Contact | Dr. Elyane Theriault | 1-800-229-3674 |
| WESTON Health and Safety | Corporate Health and Safety | (505) 837-6566 |
| Fire Department | 911 | 911 |
| Police Department | 911 | 911 |
| On-Site Coordinator- SHSC | Tom Fortner | (925) 948-2655 |
| Client Site Contact | | |
| Site Telephone or Nearest Telephone | | (925) 899-0552 |

Local Medical Emergency Facility(s)

Name of Hospital: San Leandro Hospital

Address: 13855 East 14th Street

Phone No.: 510-357-6500

Name of Contact: Emergency Room

Phone No.: 911

Type of Service:

- ☐ Physical trauma only
☐ Chemical exposure only
☒ Physical trauma and chemical exposure
☒ Available 24 hours

Route to Hospital (written detail):

Make a right onto 105th Avenue. Make a right onto San Leandro Street. Make a right onto East 14th Street.

Travel time from site:

8 minutes

Distance to hospital:

3.11 miles

Name/no. of 24-hr ambulance service:
911 /

Secondary or Specialty Service Provider

Name of Hospital:

Address:

Phone No.:

Name of Contact: Emergency Room

Phone No.: 911

Type of Service:

- ☐ Physical trauma only
☐ Chemical exposure only
☐ Physical trauma and chemical exposure
☐ Available 24 hours

Route to Hospital (written detail):

Travel time from site:

minutes

Distance to hospital:

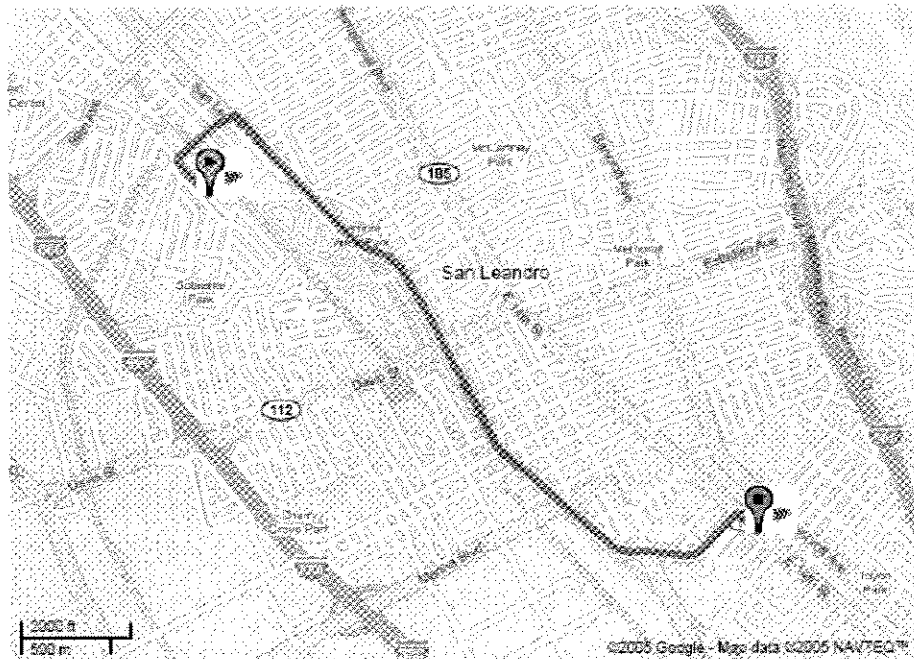
miles

Name/no. of 24-hr ambulance service:
911 /

Figure 1. Route to Hospital

Refer to the map provided on the following page.

Hospital Route Map



Start address: 10800 Edes Ave
Oakland, CA 94603
End address: 13855 CA-185
San Leandro, CA 94578

Distance: 3.2 mi (about 6 mins)

1. Head **northwest** from **Edes Ave** - go 0.2 mi
2. Turn **right** at **105th Ave** - go 0.3 mi
3. Turn **right** at **San Leandro St** - go 0.4 mi
4. Continue on **San Leandro Blvd** - go 2.2 mi
5. Turn **right** at **E 14th St** - go 0.1 mi

San Leandro Hospital: Emergency Services
13855 E 14th St, San Leandro, CA
(510) 667-4545

CONTINGENCIES-FORM 16

Response Plans

| | | | | |
|---|---|-------------------------------------|----------------------------------|---|
| Medical - General Provide first aid, if trained; assess and determine need for further medical assistance. Transport, or arrange for transport, after appropriate decontamination. | First Aid Kit: (1) 5 man | Type General field first aid kit | Location WESTON field vehicle | Special First-Aid Procedures: Cyanides on-site <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No If yes, contact LMF. Do they have antidote kit? <input type="checkbox"/> Yes <input type="checkbox"/> No |
| | Eyewash required <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Type | Location | HF on-site <input type="checkbox"/> Yes <input type="checkbox"/> No If yes, need neutralizing ointment for first-aid kit. Contact LMF. |
| | Shower required <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Type | Location | |

Plan for Response to Spill/Release

Plan for Response to Fire/Explosion

Fire Extinguishers ABC

In the event of a spill or release, ensure safety, assess situation, and perform containment and control measures, as appropriate.

- Cleanup per MSDSs if small; or sound alarm, call for assistance, notify Emergency Coordinator
- Evacuate to pre-determined safe place
- Account for personnel
- Determine if team can respond safely
- Mobilize per Site Spill Response Plan

In the event of a fire or explosion, ensure personal safety, assess situation, and perform containment and control measures, as appropriate:

- Sound alarm and call for assistance, notify Emergency Coordinator
- Evacuate to predetermined safe place
- Account for personnel
- Use fire extinguisher only if safe and trained in its use
- Stand by to inform emergency responders of materials and conditions

Type/Location
ABC/WESTON field vehicle

Description of Spill Response Gear

Location

Description (Other Fire Response Equipment)

Location

Plan to Respond to Security Problems

Local police shall be contacted in the event of a security problem – Dial 911.

DECONTAMINATION PLAN-FORM 17**Personnel Decontamination**

Consistent with the levels of protection required, step-by-step procedures for personnel decontamination for each level of protection are attached.

Levels of Protection Required for Decontamination Personnel

The levels of protection required for personnel assisting with decontamination will be:

☐ Level B

☐ Level C

☒ Level D

Modifications include:

Disposition of Decontamination Wastes

Provide a description of waste disposition, including identification of storage area, hauler, and final disposal site, if applicable:

Used PPE and disposable sampling equipment will be double bagged in plastic trash bags and disposed of in a municipal refuse dumpster. These wastes are not considered hazardous and can be sent to a municipal landfill. Any PPE or dedicated equipment that is to be disposed of that can still be reused will be rendered inoperable before disposal.

Decontamination fluids that will be generated in the sampling event will consist of water and residual contaminants. The volume and concentration of the decontamination fluid will be sufficiently low to allow disposal to the sewer system.

Soil cuttings generated during the subsurface sampling will be containerized in 55-gallon drums and profiled for proper disposal at a licensed facility.

Equipment Decontamination

A procedure for decontamination steps required for non-sampling equipment and heavy machinery follows:

The hand auger will be decontaminated using a hot water steam cleaning process.

Sampling Equipment Decontamination

Sampling equipment will be decontaminated in accordance with the following procedure:

If non-dedicated sampling equipment is used, it will be washed in a tub with a mixture of potable water and non-phosphate detergent and scrubbed with brushes; rinsed three times with deionized water, and allowed to air dry between sample locations.

LEVEL D/MODIFIED LEVEL D DECONTAMINATION PLAN FORM 18

Check indicated functions or add steps, as necessary:

| Function | Description of Process, Solution, and Container |
|----------|---|
|----------|---|

| | |
|---|--|
| <input checked="" type="checkbox"/> Segregated equipment drop | Plastic sheeting and/or clean with a damp towel. |
|---|--|

| | |
|--|--|
| <input type="checkbox"/> Boot cover and glove wash | |
|--|--|

| | |
|---|--|
| <input type="checkbox"/> Boot cover and glove rinse | |
|---|--|

| | |
|--|--|
| <input type="checkbox"/> Tape removal - outer glove and boot | |
|--|--|

| | |
|---|--|
| <input type="checkbox"/> Boot cover removal | |
|---|--|

| | |
|---|---|
| <input checked="" type="checkbox"/> Outer glove removal | Remove inside-out. Double-bag for disposal. |
|---|---|

HOTLINE

| | |
|--|--|
| <input type="checkbox"/> Suit/safety boot wash | |
|--|--|

| | |
|--|--|
| <input type="checkbox"/> Suit/boot/glove rinse | |
|--|--|

| | |
|--|--|
| <input type="checkbox"/> Safety boot removal | |
|--|--|

| | |
|---------------------------------------|--|
| <input type="checkbox"/> Suit removal | |
|---------------------------------------|--|

| | |
|---|--|
| <input type="checkbox"/> Inner glove wash | |
|---|--|

| | |
|--|--|
| <input type="checkbox"/> Inner glove rinse | |
|--|--|

| | |
|--|--|
| <input type="checkbox"/> Inner glove removal | |
|--|--|

| | |
|---|--|
| <input type="checkbox"/> Inner clothing removal | |
|---|--|

CONTAMINATION REDUCTION ZONE (CRZ)/SAFE ZONE BOUNDARY

| | |
|-------------------------------------|--|
| <input type="checkbox"/> Field wash | |
|-------------------------------------|--|

| | |
|----------------------------------|--|
| <input type="checkbox"/> Redress | |
|----------------------------------|--|

Disposal Plan, End of Day:

All waste will be double-bagged in plastic trash bags. Waste may be stored in a bucket or drum on-site on a daily basis.

Disposal Plan, End of Week:

All waste will be double-bagged in plastic trash bags.

Disposal Plan, End of Project:

Double-bagged waste will be disposed of in an appropriate municipal refuse dumpster. Alternatively, it will remain onsite in 55-gallon drums for subsequent disposal by EPA or WESTON.

SITE PERSONNEL AND CERTIFICATION STATUS-FORM 21

WESTON

| | |
|---|--|
| Name: Joe De Fao Title: Project Manager/Field Sampling QC Coordinator Task(s): All Certification Level or Description: <input checked="" type="checkbox"/> Medical Current <input checked="" type="checkbox"/> Training Current <input type="checkbox"/> Fit Test Current (Qual.) <input type="checkbox"/> Fit Test Current (Quant.) | Name: Tom Fortner Title: Field Manager Task(s): 1-2 Certification Level or Description: <input checked="" type="checkbox"/> Medical Current <input checked="" type="checkbox"/> Training Current <input type="checkbox"/> Fit Test Current (Qual.) <input type="checkbox"/> Fit Test Current (Quant.) |
| Name: Michelle Zehr Title: Associate Geoscientist Task(s): All Certification Level or Description: <input checked="" type="checkbox"/> Medical Current <input checked="" type="checkbox"/> Training Current <input type="checkbox"/> Fit Test Current (Qual.) <input type="checkbox"/> Fit Test Current (Quant.) | Name: Mindy Smith Title: Asst. Project Scientist Task(s): 1-2 Certification Level or Description: <input checked="" type="checkbox"/> Medical Current <input checked="" type="checkbox"/> Training Current <input type="checkbox"/> Fit Test Current (Qual.) <input type="checkbox"/> Fit Test Current (Quant.) |
| Name: Title: Task(s): Certification Level or Description: <input type="checkbox"/> Medical Current <input type="checkbox"/> Training Current <input type="checkbox"/> Fit Test Current (Qual.) <input type="checkbox"/> Fit Test Current (Quant.) | Name: Title: Task(s): Certification Level or Description: <input type="checkbox"/> Medical Current <input type="checkbox"/> Training Current <input type="checkbox"/> Fit Test Current (Qual.) <input type="checkbox"/> Fit Test Current (Quant.) |
| Name: Title: Task(s): Certification Level or Description: <input type="checkbox"/> Medical Current <input type="checkbox"/> Training Current <input type="checkbox"/> Fit Test Current (Qual.) <input type="checkbox"/> Fit Test Current (Quant.) | Name: Title: Task(s): Certification Level or Description: <input type="checkbox"/> Medical Current <input type="checkbox"/> Training Current <input type="checkbox"/> Fit Test Current (Qual.) <input type="checkbox"/> Fit Test Current (Quant.) |
| Name: Title: Task(s): Certification Level or Description: <input type="checkbox"/> Medical Current <input type="checkbox"/> Training Current <input type="checkbox"/> Fit Test Current (Qual.) <input type="checkbox"/> Fit Test Current (Quant.) | Name: Title: Task(s): Certification Level or Description: <input type="checkbox"/> Medical Current <input type="checkbox"/> Training Current <input type="checkbox"/> Fit Test Current (Qual.) <input type="checkbox"/> Fit Test Current (Quant.) |
| Name: Title: Task(s): Certification Level or Description: <input type="checkbox"/> Medical Current <input type="checkbox"/> Training Current <input type="checkbox"/> Fit Test Current (Qual.) <input type="checkbox"/> Fit Test Current (Quant.) | Name: Title: Task(s): Certification Level or Description: <input type="checkbox"/> Medical Current <input type="checkbox"/> Training Current <input type="checkbox"/> Fit Test Current (Qual.) <input type="checkbox"/> Fit Test Current (Quant.) |

TRAINING CURRENT - Training: All personnel, including visitors, entering the exclusion or contamination reduction zones must have certifications of completion of training in accordance with OSHA 29 CFR 1910, 29 CFR 1926, or 29 CFR 1910.120.

FIT TEST CURRENT - Respirator Fit Testing: All persons, including visitors, entering any area requiring the use or potential use of any negative pressure respirator must have had, as a minimum, a qualitative fit test, administered in accordance with OSHA 29 CFR 1910.134 or ANSI, within the last 12 months. If site conditions require the use of a full-face, negative-pressure, air-purifying respirator for protection from asbestos or lead, employees must have had a qualitative fit test, administered according to OSHA 29 CFR 1910.1001 or 1025/1926, within the last 6 months.

MEDICAL CURRENT - Medical Monitoring Requirements: All personnel, including visitors, entering the exclusion or contamination reduction zones must be certified as medically fit to work and to wear a respirator, if appropriate, in accordance with 29 CFR 1910, 29 CFR 1926/1910, or 29 CFR 1910.120.

The Site Health and Safety Coordinator is responsible for verifying all certifications and fit tests.

| HEALTH AND SAFETY PLAN APPROVAL/SIGNOFF FORM-FORM 23 | |
|--|---------------------------|
| Site Name: East Bay Habitat for Humanity, 10800 Edes Avenue Site | WO#: 12767.061.003 |
| 10800 Edes Avenue Site, Oakland, California | |
| I understand, agree to, and will conform with the information set forth in this Health and Safety Plan (and attachments) and discussed in the personnel health and safety briefing(s). | |

| HEALTH AND SAFETY PLAN APPROVAL/SIGNOFF FORM-FORM 23 | |
|--|---------------------------|
| Site Name: East Bay Habitat for Humanity, 10800 Edes Avenue Site | WO#: 12767.061.003 |
| 10800 Edes Avenue Site, Oakland, California | |
| I understand, agree to, and will conform with the information set forth in this Health and Safety Plan (and attachments) and discussed in the personnel health and safety briefing(s). | |

| HEALTH AND SAFETY PLAN APPROVAL/SIGNOFF FORM-FORM 23 | |
|--|---------------------------|
| Site Name: East Bay Habitat for Humanity, 10800 Edes Avenue Site | WO#: 12767.061.003 |
| 10800 Edes Avenue Site, Oakland, California | |
| I understand, agree to, and will conform with the information set forth in this Health and Safety Plan (and attachments) and discussed in the personnel health and safety briefing(s). | |

| HEALTH AND SAFETY PLAN APPROVAL/SIGNOFF FORM-FORM 23 | |
|--|---------------------------|
| Site Name: East Bay Habitat for Humanity, 10800 Edes Avenue Site | WO#: 12767.061.003 |
| 10800 Edes Avenue Site, Oakland, California | |
| I understand, agree to, and will conform with the information set forth in this Health and Safety Plan (and attachments) and discussed in the personnel health and safety briefing(s). | |

| HEALTH AND SAFETY PLAN APPROVAL/SIGNOFF FORM-FORM 23 | |
|--|---------------------------|
| Site Name: East Bay Habitat for Humanity, 10800 Edes Avenue Site | WO#: 12767.061.003 |
| 10800 Edes Avenue Site, Oakland, California | |
| I understand, agree to, and will conform with the information set forth in this Health and Safety Plan (and attachments) and discussed in the personnel health and safety briefing(s). | |

Date _____

[illegible]

TRAINING AND BRIEFING TOPICS-FORM 24

The following items will be covered at the site-specific training meeting, daily or periodically.

| | |
|---|---|
| <input checked="" type="checkbox"/> Site characterization and analysis, Sec. 3.0, 29 CFR 1910.120 I | <input type="checkbox"/> Level A |
| <input checked="" type="checkbox"/> Physical hazards, HASP Form 07 | <input type="checkbox"/> Level B |
| <input checked="" type="checkbox"/> Chemical hazards, HASP Form 04 | <input type="checkbox"/> Level C |
| <input checked="" type="checkbox"/> Animal bites, stings, and poisonous plants | <input checked="" type="checkbox"/> Level D |
| <input type="checkbox"/> Etiologic (infectious) agents | <input checked="" type="checkbox"/> Monitoring, 29 CFR 1910.120 (h) |
| <input type="checkbox"/> Site control, 29 CFR 1910.120 d | <input checked="" type="checkbox"/> Decontamination, 29 CFR 1910.120 (k) |
| <input checked="" type="checkbox"/> Engineering controls and work practices, 29 CFR 1910.120 (g) | <input type="checkbox"/> Emergency response, 29 CFR 1910.120 (l) |
| <input checked="" type="checkbox"/> Heavy machinery | <input type="checkbox"/> Elements of an emergency response, 29 CFR 1910.120 (l) |
| <input type="checkbox"/> Forklift | <input checked="" type="checkbox"/> Procedures for handling site emergency incidents, 29 CFR 1910.120 (l) |
| <input type="checkbox"/> Backhoe | <input type="checkbox"/> Off-site emergency response, 29 CFR 1910.120 (l) |
| <input checked="" type="checkbox"/> Equipment | <input checked="" type="checkbox"/> Handling drums and containers, 29 CFR 1910.120 (j) |
| <input type="checkbox"/> Tools | <input type="checkbox"/> Opening drums and containers |
| <input type="checkbox"/> Ladder, 29 CFR 1910.27 (d)/29 CFR 1926 | <input type="checkbox"/> Electrical material handling equipment |
| <input checked="" type="checkbox"/> Overhead and underground utilities | <input type="checkbox"/> Radioactive waste |
| <input type="checkbox"/> Scaffolds | <input type="checkbox"/> Shock-sensitive waste |
| <input type="checkbox"/> Structural integrity | <input type="checkbox"/> Laboratory waste packs |
| <input type="checkbox"/> Unguarded openings - wall, floor, ceilings | <input type="checkbox"/> Sampling drums and containers |
| <input type="checkbox"/> Pressurized air cylinders | <input type="checkbox"/> Shipping and transport, 49 CFR 172.101, IATA |
| <input checked="" type="checkbox"/> Personal protective equipment, 29 CFR 1910.120 (g); 29 CFR 1910.134 | <input type="checkbox"/> Tank and vault procedures |
| <input type="checkbox"/> Respiratory protection, 29 CFR 1910.120 (g); ANSI Z88.2 | <input type="checkbox"/> Illumination, 29 CFR 1910.120 (m) |
| <input checked="" type="checkbox"/> Drilling Safety | <input type="checkbox"/> Sanitation, 29 CFR 1910.120 (n) |
| <input type="checkbox"/> | <input type="checkbox"/> |
| <input type="checkbox"/> | <input type="checkbox"/> |
| <input type="checkbox"/> | <input type="checkbox"/> |

ATTACHMENT A
CHEMICAL CONTAMINANTS DATA SHEETS
FORM 25

NIOSH Pocket Guide to Chemical Hazards

| | | |
|---|--|---|
| Aldrin | | CAS 309-00-2 |
| $C_{12}H_8Cl_6$ | | RTECS 1Q2100000 |
| Synonyms & Trade Names 1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a-hexahydro-endo-1,4-exo-5,8-dimethanonaphthalene; HHDN; Octalene | | DOT ID & Guide 2761 151 |
| Exposure Limits | NIOSH REL: Ca TWA 0.25 mg/m ³ [skin] See Appendix A | |
| | OSHA PEL: TWA 0.25 mg/m ³ [skin] | |
| IDLH Ca [25 mg/m ³] See: 309002 | | Conversion |
| Physical Description Colorless to dark-brown crystalline solid with a mild chemical odor. [Note: Formerly used as an insecticide.] | | |
| MW: 364.9 | BP: Decomposes | MLT: 219°F |
| VP: 0.00008 mmHg | IP: ? | Sp.Gr: 1.60 |
| FLP: NA | UEL: NA | LEL: NA |
| Noncombustible Solid, but may be dissolved in flammable liquids. | | |
| Incompatibilities & Reactivities Concentrated mineral acids, active metals, acid catalysts, acid oxidizing agents, phenol | | |
| Measurement Methods NIOSH 5502 See: NMAM or OSHA Methods | | |
| Personal Protection & Sanitation Skin: Prevent skin contact Eyes: Prevent eye contact Wash skin: When contaminated/Daily Remove: When wet or contaminated Change: Daily Provide: Eyewash, Quick drench | | First Aid (See procedures) Eye: Irrigate immediately Skin: Soap wash immediately Breathing: Respiratory support Swallow: Medical attention immediately |
| Important additional information about respirator selection Respirator Recommendations NIOSH At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode/(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus Escape: (APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having a high-efficiency particulate filter/Any appropriate escape-type, self-contained breathing apparatus | | |
| Exposure Routes inhalation, skin absorption, ingestion, skin and/or eye contact | | |
| Symptoms Headache, dizziness; nausea, vomiting, malaise (vague feeling of discomfort); myoclonic jerks of limbs; clonic, tonic convulsions; coma; hematuria (blood in the urine), azotemia; [potential occupational carcinogen] | | |
| Target Organs central nervous system, liver, kidneys, skin | | |
| Cancer Site [in animals: tumors of the lungs, liver, thyroid & adrenal glands] | | |
| See also: INTRODUCTION See ICSC CARD: 0774 See MEDICAL TESTS: 0009 | | |

NIOSH Pocket Guide to Chemical Hazards

| | | | |
|--|--|--|---|
| Asbestos | | | CAS 1332-21-4 |
| Hydrated mineral silicates | | | RTECS C16475000 |
| Synonyms & Trade Names Actinolite, Actinolite asbestos, Amosite (cummingtonite-grunerite), Anthophyllite, Anthophyllite asbestos, Chrysotile, Crocidolite (Riebeckite), Tremolite, Tremolite asbestos | | | DOT ID & Guide 2212 171 (blue, brown) 2590 171 (white) |
| Exposure Limits | NIOSH REL: Ca See Appendix A See Appendix C | | |
| | OSHA PEL: [1910.1001] [1910.1101] See Appendix C | | |
| IDLH Ca [N.D.] See: IDLH INDEX | | Conversion | |
| Physical Description White or greenish (chrysotile), blue (crocidolite), or gray-green (amosite) fibrous, odorless solids. | | | |
| MW: Varies | BP: Decomposes | MLT: 1112°F (Decomposes) | Sol: Insoluble |
| VP: 0 mmHg (approx) | IP: NA | | Sp.Gr: ? |
| FLP: NA | UEL: NA | LEL: NA | |
| Noncombustible Solids | | | |
| Incompatibilities & Reactivities None reported | | | |
| Measurement Methods NIOSH 7400, 7402; OSHA ID160, ID191 See: NMAM or OSHA Methods | | | |
| Personal Protection & Sanitation Skin: Prevent skin contact Eyes: Prevent eye contact Wash skin: Daily Remove: No recommendation Change: Daily | | First Aid (See procedures) Eye: Irrigate immediately Breathing: Fresh air | |
| Important additional information about respirator selection Respirator Recommendations NIOSH At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode/(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus Escape: (APF = 50) Any air-purifying, full-facepiece respirator with a high-efficiency particulate filter/Any appropriate escape-type, self-contained breathing apparatus | | | |
| Exposure Routes inhalation, ingestion, skin and/or eye contact | | | |
| Symptoms Asbestosis (chronic exposure): dyspnea (breathing difficulty), interstitial fibrosis, restricted pulmonary function, finger clubbing; irritation eyes; [potential occupational carcinogen] | | | |
| Target Organs respiratory system, eyes | | | |
| Cancer Site [lung cancer] | | | |
| See also: INTRODUCTION See MEDICAL TESTS: 0019 | | | |

Asbestos

NIOSH considers asbestos to be a potential occupational carcinogen and recommends that exposures be reduced to the low concentration. For asbestos fibers >5 micrometers in length, NIOSH recommends a REL of 100,000 fibers per cubic meter of fibers/m³, which is equal to 0.1 fiber per cubic centimeter of air (0.1 fiber/cm³), as determined by a 400-liter air sample collected in accordance with NIOSH Analytical Method #7400. Airborne asbestos fibers are defined as those particles having (1) a length of 3 to 1 or greater and (2) the mineralogic characteristics (that is, the crystal structure and elemental composition) of the asbestos and their nonasbestiform analogs. The asbestos minerals are defined as chrysotile, crocidolite, amosite (cummingtonite-grunerite), anthophyllite, tremolite, and actinolite. In addition, airborne cleavage fragments from the nonasbestiform habits of the serpentine antigorite and lizardite, and the amphibole minerals contained in the series cummingtonite-grunerite, tremolite-ferroactinolite, and glaucophane-riebeckite should also be counted as fibers provided they meet the criteria for a fiber when viewed microscopically.

As found in 29 CFR 1910.1001, the OSHA PEL for asbestos fibers (i.e., actinolite asbestos, amosite, anthophyllite asbestos, crocidolite, and tremolite asbestos) is an 8-hour TWA airborne concentration of 0.1 fiber (longer than 5 micrometers and having diameter ratio of at least 3 to 1) per cubic centimeter of air (0.1 fiber/cm³), as determined by the membrane filter method at approximately 400X magnification with phase contrast illumination. No worker should be exposed in excess of 1 fiber/cm³ (excursion limit) as a sampling period of 30 minutes.

NIOSH Pocket Guide to Chemical Hazards

| | | |
|---|---|---|
| Benzene | | CAS 71-43-2 |
| C₆H₆ | | RTECS CY1400000 |
| Synonyms & Trade Names Benzol, Phenyl hydride | | DOT ID & Guide 1114 130 |
| Exposure Limits | NIOSH REL: Ca TWA 0.1 ppm ST 1 ppm See Appendix A | |
| | OSHA PEL: [1910.1028] TWA 1 ppm ST 5 ppm See Appendix F | |
| IDLH Ca [500 ppm] See: 71432 | | Conversion 1 ppm = 3.19 mg/m ³ |
| Physical Description Colorless to light-yellow liquid with an aromatic odor. [Note: A solid below 42°F.] | | |
| MW: 78.1 | BP: 176°F | FRZ: 42°F |
| VP: 75 mmHg | IP: 9.24 eV | Sp.Gr: 0.88 |
| FLP: 12°F | UEL: 7.8% | LEL: 1.2% |
| Class IB Flammable Liquid: FLP. below 73°F and BP at or above 100°F. | | |
| Incompatibilities & Reactivities Strong oxidizers, many fluorides & perchlorates, nitric acid | | |
| Measurement Methods NIOSH 1500, 1501, 3700, 3800; OSHA 12, 1005 See: NMAM or OSHA Methods | | |
| Personal Protection & Sanitation Skin: Prevent skin contact Eyes: Prevent eye contact Wash skin: When contaminated Remove: When wet (flammable) Change: No recommendation Provide: Eyewash, Quick drench | | First Aid (See procedures) Eye: Irrigate immediately Skin: Soap wash immediately Breathing: Respiratory support Swallow: Medical attention immediately |
| Important additional information about respirator selection Respirator Recommendations NIOSH At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode/(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus Escape: (APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister/Any appropriate escape-type, self-contained breathing apparatus | | |
| Exposure Routes inhalation, skin absorption, ingestion, skin and/or eye contact | | |
| Symptoms Irritation eyes, skin, nose, respiratory system; dizziness; headache, nausea, staggered gait; anorexia, lassitude (weakness, exhaustion); dermatitis; bone marrow depression; [potential occupational carcinogen] | | |
| Target Organs Eyes, skin, respiratory system, blood, central nervous system, bone marrow | | |
| Cancer Site [leukemia] | | |
| See also: INTRODUCTION See ICSC CARD: 0015 See MEDICAL TESTS: 0022 | | |

[NIOSH Home](#) | [NIOSH Search](#) | [Site Index](#) | [Topic List](#) | [Contact Us](#)

NIOSH Pocket Guide to Chemical Hazards

| | | |
|---|---|---|
| Cadmium dust (as Cd) | | CAS 7440-43-9 (metal) |
| Cd (metal) | | RTECS EU9800000 (metal) |
| Synonyms & Trade Names Cadmium metal: Cadmium Other synonyms vary depending upon the specific cadmium compound. | | DOT ID & Guide 2570 154 (compounds) |
| Exposure Limits | NIOSH REL*: Ca See Appendix A [*Note: The REL applies to all Cadmium compounds (as Cd).] | |
| | OSHA PEL*: [1910.1027] TWA 0.005 mg/m ³ [*Note: The PEL applies to all Cadmium compounds (as Cd).] | |
| IDLH Ca [9 mg/m ³ (as Cd)] See: IDLH INDEX | | Conversion |
| Physical Description Metal: Silver-white, blue-tinged lustrous, odorless solid. | | |
| MW: 112.4 | BP: 1409°F | MLT: 610°F |
| VP: 0 mmHg (approx) | IP: NA | Sp.Gr: 8.65 (metal) |
| Fl.P: NA | UEL: NA | LEL: NA |
| Metal: Noncombustible Solid in bulk form, but will burn in powder form. | | |
| Incompatibilities & Reactivities Strong oxidizers; elemental sulfur, selenium & tellurium | | |
| Measurement Methods NIOSH 7048; OSHA ID121, ID125G, ID189, ID206 See: NMAM or OSHA Methods | | |
| Personal Protection & Sanitation Skin: No recommendation Eyes: No recommendation Wash skin: Daily Remove: No recommendation Change: Daily | | First Aid (See procedures) Eye: Irrigate immediately Skin: Soap wash Breathing: Respiratory support Swallow: Medical attention immediately |
| Important additional information about respirator selection Respirator Recommendations NIOSH At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode/(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus Escape: (APF = 50) Any air-purifying, full-facepiece respirator with a high-efficiency particulate filter/Any appropriate escape-type, self-contained breathing apparatus | | |
| Exposure Routes inhalation, ingestion | | |
| Symptoms Pulmonary edema, dyspnea (breathing difficulty), cough, chest tightness, substernal (occurring beneath the sternum) pain; headache; chills, muscle aches; nausea, vomiting, diarrhea; anosmia (loss of the sense of smell), emphysema, proteinuria, mild anemia; [potential occupational carcinogen] | | |
| Target Organs respiratory system, kidneys, prostate, blood | | |
| Cancer Site [prostatic & lung cancer] | | |
| See also: INTRODUCTION See ICSC CARD: 0020 See MEDICAL TESTS: 0035 | | |

NIOSH Pocket Guide to Chemical Hazards

| | | | |
|---|--|---|--|
| Coal tar pitch volatiles | | CAS 65996-93-2 | |
| | | RTECS GF8655000 | |
| Synonyms & Trade Names Synonyms vary depending upon the specific compound (e.g., pyrene, phenanthrene, acridine, chrysene, anthracene & benzo(a) pyrene). [Note: NIOSH considers coal tar, coal tar pitch, and creosote to be coal tar products.] | | DOT ID & Guide | |
| Exposure Limits | NIOSH REL: Ca TWA 0.1 mg/m ³ (cyclohexane-extractable fraction) See Appendix A See Appendix C | | |
| | OSHA PEL: TWA 0.2 mg/m ³ (benzene-soluble fraction) [1910.1002] See Appendix C | | |
| IDLH Ca [80 mg/m ³] See: 65996932 | | Conversion | |
| Physical Description Black or dark-brown amorphous residue. | | | |
| Properties vary depending upon the specific compound. | | | |
| | | | |
| | | | |
| Combustible Solids | | | |
| Incompatibilities & Reactivities Strong oxidizers | | | |
| Measurement Methods OSHA 58 See: NMAM or OSHA Methods | | | |
| Personal Protection & Sanitation Skin: Prevent skin contact Eyes: Prevent eye contact Wash skin: Daily Remove: No recommendation Change: Daily | | First Aid (See procedures) Eye: Irrigate immediately Skin: Soap wash immediately Breathing: Respiratory support Swallow: Medical attention immediately | |
| Important additional information about respirator selection Respirator Recommendations NIOSH At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode/(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus Escape: (APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having a high-efficiency particulate filter/Any appropriate escape-type, self-contained breathing apparatus | | | |
| Exposure Routes inhalation, skin and/or eye contact | | | |
| Symptoms Dermatitis, bronchitis, [potential occupational carcinogen] | | | |
| Target Organs respiratory system, skin, bladder, kidneys | | | |
| Cancer Site [lung, kidney & skin cancer] | | | |
| See also: INTRODUCTION See ICSC CARD: 1415 See MEDICAL TESTS: 0054 | | | |

NIOSH Pocket Guide to Chemical Hazards

| | | | |
|---|--|---|----------------|
| DDT | | CAS 50-29-3 | |
| (C ₆ H ₄ Cl) ₂ CHCCl ₃ | | RTECS KJ3325000 | |
| Synonyms & Trade Names p,p'-DDT; Dichlorodiphenyltrichloroethane; 1,1,1-Trichloro-2,2-bis(p-chlorophenyl)ethane | | DOT ID & Guide 2761 151 | |
| Exposure Limits | NIOSH REL: Ca TWA 0.5 mg/m ³ See Appendix A | | |
| | OSHA PEL: TWA 1 mg/m ³ [skin] | | |
| IDLH Ca [500 mg/m ³] See: 50293 | | Conversion | |
| Physical Description Colorless crystals or off-white powder with a slight, aromatic odor. [pesticide] | | | |
| MW: 354.5 | BP: 230°F (Decomposes) | MLT: 227°F | Sol: Insoluble |
| VP: 0.0000002 mmHg | IP: ? | | Sp.Gr: 0.99 |
| FLP: 162-171°F | UEL: ? | LEL: ? | |
| Combustible Solid | | | |
| Incompatibilities & Reactivities Strong oxidizers, alkalis | | | |
| Measurement Methods NIOSH S274 (II-3) See: NMAM or OSHA Methods | | | |
| Personal Protection & Sanitation Skin: Prevent skin contact Eyes: Prevent eye contact Wash skin: When contaminated/Daily Remove: When wet or contaminated Change: Daily Provide: Eyewash, Quick drench | | First Aid (See procedures) Eye: Irrigate immediately Skin: Soap wash promptly Breathing: Respiratory support Swallow: Medical attention immediately | |
| Important additional information about respirator selection Respirator Recommendations NIOSH At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode/(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus Escape: (APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having a high-efficiency particulate filter/Any appropriate escape-type, self-contained breathing apparatus | | | |
| Exposure Routes inhalation, skin absorption, ingestion, skin and/or eye contact | | | |
| Symptoms Irritation eyes, skin; paresthesia tongue, lips, face; tremor; anxiety, dizziness, confusion, malaise (vague feeling of discomfort), headache, lassitude (weakness, exhaustion); convulsions; paresis hands; vomiting; [potential occupational carcinogen] | | | |
| Target Organs Eyes, skin, central nervous system, kidneys, liver, peripheral nervous system | | | |
| Cancer Site [in animals: liver, lung & lymphatic tumors] | | | |
| See also: INTRODUCTION See ICSC CARD: 0034 See MEDICAL TESTS: 0065 | | | |

[NIOSH Home](#) |
 [NIOSH Search](#) |
 [Site Index](#) |
 [Topic List](#) |
 [Contact Us](#)

NIOSH Pocket Guide to Chemical Hazards

| | | | |
|--|------------------------------|---|----------------------------|
| Gasoline | | | CAS 8006-61-9 |
| | | | RTECS LX3300000 |
| Synonyms & Trade Names Motor fuel, Motor spirits, Natural gasoline, Petrol [Note: A complex mixture of volatile hydrocarbons (paraffins, cycloparaffins & aromatics).] | | | DOT ID & Guide 1203 128 |
| Exposure Limits | NIOSH REL: Ca See Appendix A | | |
| | OSHA PEL†: none | | |
| IDLH Ca [N.D.] See: IDLH INDEX | | Conversion 1 ppm 2.95 mg/m ³ (approx) | |
| Physical Description Clear liquid with a characteristic odor. | | | |
| MW: 72 (approx) | BP: 102°F | FRZ: ? | Sol: Insoluble |
| VP: 38-300 mmHg | IP: ? | | Sp.Gr(60°F): 0.72-0.76 |
| FLP: -45°F | UEL: 7.6% | LEL: 1.4% | |
| Class IB Flammable Liquid: FLP, below 73°F and BP at or above 100°F. | | | |
| Incompatibilities & Reactivities Strong oxidizers such as peroxides, nitric acid & perchlorates | | | |
| Measurement Methods OSHA PV2028 See: NMAM or OSHA Methods | | | |
| Personal Protection & Sanitation Skin: Prevent skin contact Eyes: Prevent eye contact Wash skin: When contaminated Remove: When wet (flammable) Change: No recommendation Provide: Eyewash, Quick drench | | First Aid (See procedures) Eye: Irrigate immediately Skin: Soap flush immediately Breathing: Respiratory support Swallow: Medical attention immediately | |
| Important additional information about respirator selection Respirator Recommendations NIOSH At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode/(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus Escape: (APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister/Any appropriate escape-type, self-contained breathing apparatus | | | |
| Exposure Routes inhalation, skin absorption, ingestion, skin and/or eye contact | | | |
| Symptoms Irritation eyes, skin, mucous membrane; dermatitis; headache, lassitude (weakness, exhaustion), blurred vision, dizziness, slurred speech, confusion, convulsions; chemical pneumonitis (aspiration liquid); possible liver, kidney damage; [potential occupational carcinogen] | | | |
| Target Organs Eyes, skin, respiratory system, central nervous system, liver, kidneys | | | |
| Cancer Site [in animals: liver & kidney cancer] | | | |
| See also: INTRODUCTION | | | |

NIOSH Pocket Guide to Chemical Hazards

| | | | |
|---|---|--|--------------|
| Heptachlor | | CAS 76-44-8 | |
| C ₁₀ H ₅ Cl ₇ | | RTECS PC0700000 | |
| Synonyms & Trade Names 1,4,5,6,7,8,8-Heptachloro-3a,4,7,7a-tetrahydro-4,7-methanoindene | | DOT ID & Guide 2761 151 (organochlorine pesticide, solid) | |
| Exposure Limits | NIOSH REL: Ca TWA 0.5 mg/m ³ [skin] See Appendix A | | |
| | OSHA PEL: TWA 0.5 mg/m ³ [skin] | | |
| IDLH Ca [35 mg/m ³] See: 76448 | | Conversion | |
| Physical Description White to light-tan crystals with a camphor-like odor. [insecticide] | | | |
| MW: 373.4 | BP: 293°F (Decomposes) | MLT: 203°F | Sol: 0.0006% |
| VP(77°F): 0.0003 mmHg | IP: ? | | Sp.Gr: 1.66 |
| F.L.P: NA | UEL: NA | LEL: NA | |
| Noncombustible Solid, but may be dissolved in flammable liquids. | | | |
| Incompatibilities & Reactivities Iron, rust | | | |
| Measurement Methods NIOSH S287 (II-5); OSHA PV2029 See: NMAM or OSHA Methods | | | |
| Personal Protection & Sanitation Skin: Prevent skin contact Eyes: Prevent eye contact Wash skin: When contaminated/Daily Remove: When wet or contaminated Change: Daily Provide: Eyewash, Quick drench | | First Aid (See procedures) Eye: Irrigate immediately Skin: Soap wash immediately Breathing: Respiratory support Swallow: Medical attention immediately | |
| Important additional information about respirator selection Respirator Recommendations NIOSH At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode/(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus Escape: (APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having a high-efficiency particulate filter/Any appropriate escape-type, self-contained breathing apparatus | | | |
| Exposure Routes inhalation, skin absorption, ingestion, skin and/or eye contact | | | |
| Symptoms In animals: tremor, convulsions; liver damage; [potential occupational carcinogen] | | | |
| Target Organs central nervous system, liver | | | |
| Cancer Site [in animals: liver cancer] | | | |
| See also: INTRODUCTION See ICSC CARD: 0743 | | | |

[NIOSH Home](#) |
 [NIOSH Search](#) |
 [Site Index](#) |
 [Topic List](#) |
 [Contact Us](#)

NIOSH Pocket Guide to Chemical Hazards

| | | |
|---|--|---|
| Lead | | CAS 7439-92-1 |
| Pb | | RTECS OF7525000 |
| Synonyms & Trade Names Lead metal, Plumbum | | DOT ID & Guide |
| Exposure Limits | NIOSH REL*: TWA 0.050 mg/m ³ See Appendix C [*Note: The REL also applies to other lead compounds (as Pb) -- see Appendix C.] | |
| | OSHA PEL*: [1910.1025] TWA 0.050 mg/m ³ See Appendix C [*Note: The PEL also applies to other lead compounds (as Pb) -- see Appendix C.] | |
| IDLH 100 mg/m ³ (as Pb) See: 7439921 | | Conversion |
| Physical Description A heavy, ductile, soft, gray solid. | | |
| MW: 207.2 | BP: 3164°F | MLT: 621°F |
| VP: 0 mmHg (approx) | IP: NA | Sp.Gr: 11.34 |
| F.P: NA | UEL: NA | LEL: NA |
| Noncombustible Solid in bulk form. | | |
| Incompatibilities & Reactivities Strong oxidizers, hydrogen peroxide, acids | | |
| Measurement Methods NIOSH 7082, 7105, 7300, 7700, 7701, 7702, 9100, 9105; OSHA ID121, ID125G, ID206 See: NMAM or OSHA Methods | | |
| Personal Protection & Sanitation Skin: Prevent skin contact Eyes: Prevent eye contact Wash skin: Daily Remove: When wet or contaminated Change: Daily | | First Aid (See procedures) Eye: Irrigate immediately Skin: Soap flush promptly Breathing: Respiratory support Swallow: Medical attention immediately |
| Important additional information about respirator selection Respirator Recommendations NIOSH/OSHA Up to 0.5 mg/m³: (APF = 10) Any air-purifying respirator with a high-efficiency particulate filter/(APF = 10) Any supplied-air respirator Up to 1.25 mg/m³: (APF = 25) Any supplied-air respirator operated in a continuous-flow mode/(APF = 25) Any powered, air-purifying respirator with a high-efficiency particulate filter Up to 2.5 mg/m³: (APF = 50) Any air-purifying, full-facepiece respirator with a high-efficiency particulate filter/(APF = 50) Any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode/(APF = 50) Any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter/(APF = 50) Any self-contained breathing apparatus with a full facepiece/(APF = 50) Any supplied-air respirator with a full facepiece Up to 50 mg/m³: (APF = 1000) Any supplied-air respirator operated in a pressure-demand or other positive-pressure mode Up to 100 mg/m³: (APF = 2000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode Emergency or planned entry into unknown concentrations or IDLH conditions: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode/(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus Escape: (APF = 50) Any air-purifying, full-facepiece respirator with a high-efficiency particulate filter/Any appropriate escape-type, self-contained breathing apparatus | | |
| Exposure Routes inhalation, ingestion, skin and/or eye contact | | |
| Symptoms Lassitude (weakness, exhaustion), insomnia; facial pallor; anorexia, weight loss, malnutrition; constipation, abdominal pain, colic; anemia; gingival lead line; tremor; paralysis wrist, ankles; encephalopathy; kidney disease; irritation | | |

Lead

NIOSH considers "Lead" to mean metallic lead, lead oxides, and lead salts (including organic salts such as lead soaps but excluding arsenate).

The NIOSH REL for lead (8-hour TWA) is 0.050 mg/m^3 ; air concentrations should be maintained so that worker blood lead remains below $0.060 \text{ mg Pb/100 g}$ of whole blood.

OSHA considers "Lead" to mean metallic lead, all inorganic lead compounds (lead oxides and lead salts), and a class of organic compounds called soaps; all other lead compounds are excluded from this definition.

The OSHA PEL (8-hour TWA) is 0.050 mg/m^3 ; other OSHA requirements can be found in 29 CFR 1910.1025. The OSHA PEL for lead in "non-ferrous foundries with less than 20 employees" is 0.075 mg/m^3 .

eyes; hypotension

Target Organs Eyes, gastrointestinal tract, central nervous system, kidneys, blood, gingival tissue

See also: [INTRODUCTION](#) See ICSC CARD: 0052 See MEDICAL TESTS: 0127

[NIOSH Home](#) | [NIOSH Search](#) | [Site Index](#) | [Topic List](#) | [Contact Us](#)

NIOSH Pocket Guide to Chemical Hazards

| | | | |
|---|-------------------------------------|--|---------------|
| Methoxychlor | | CAS 72-43-5 | |
| $(C_6H_4OCH_3)_2CHCCl_3$ | | RTECS KJ3675000 | |
| Synonyms & Trade Names p,p'-Dimethoxydiphenyltrichloroethane; DMDT; Methoxy-DDT; 2,2-bis(p-Methoxyphenyl)-1,1,1-trichloroethane; 1,1,1-Trichloro-2,2-bis-(p-methoxyphenyl)ethane | | DOT ID & Guide 2761 151 (organochlorine pesticide, solid, n.o.s.) | |
| Exposure Limits | NIOSH REL: Ca See Appendix A | | |
| | OSHA PEL†: TWA 15 mg/m ³ | | |
| IDLH Ca [5000 mg/m ³] See: 72435 | | Conversion | |
| Physical Description Colorless to light-yellow crystals with a slight, fruity odor. [insecticide] | | | |
| MW: 345.7 | BP: Decomposes | MLT: 171°F | Sol: 0.00001% |
| VP: Very low | IP: ? | | Sp.Gr: 1.41 |
| FLP: ? | UEL: ? | LEL: ? | |
| Combustible Solid, but difficult to burn. | | | |
| Incompatibilities & Reactivities Oxidizers | | | |
| Measurement Methods NIOSH S371 (II-4); OSHA PV2038 See: NMAM or OSHA Methods | | | |
| Personal Protection & Sanitation Skin: Prevent skin contact Eyes: No recommendation Wash skin: When contaminated/Daily Remove: When wet or contaminated Change: Daily | | First Aid (See procedures) Skin: Soap wash Breathing: Fresh air Swallow: Medical attention immediately | |
| Important additional information about respirator selection Respirator Recommendations NIOSH At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode/(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus Escape: (APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having a high-efficiency particulate filter/Any appropriate escape-type, self-contained breathing apparatus | | | |
| Exposure Routes inhalation, ingestion | | | |
| Symptoms In animals: fasciculation, trembling, convulsions; kidney, liver damage; [potential occupational carcinogen] | | | |
| Target Organs central nervous system, liver, kidneys | | | |
| Cancer Site [in animals: liver & ovarian cancer] | | | |
| See also: INTRODUCTION See ICSC CARD: 1306 | | | |

NIOSH Pocket Guide to Chemical Hazards

| | | |
|--|--|---|
| Nitric acid | | CAS 7697-37-2 |
| HNO₃ | | RTECS QU5775000 |
| Synonyms & Trade Names Aqua fortis, Engravers acid, Hydrogen nitrate, Red fuming nitric acid (RFNA), White fuming nitric acid (WFNA) | | DOT ID & Guide 1760 154 (<=40% acid) 2031 157 (>40% acid) 2032 157 (fuming) |
| Exposure Limits | NIOSH REL: TWA 2 ppm (5 mg/m ³) ST 4 ppm (10 mg/m ³) | |
| | OSHA PEL†: TWA 2 ppm (5 mg/m ³) | |
| IDLH 25 ppm See: 7697372 | | Conversion 1 ppm = 2.58 mg/m ³ |
| Physical Description Colorless, yellow, or red, fuming liquid with an acid, suffocating odor. [Note: Often used in an aqueous solution. Fuming nitric acid is concentrated nitric acid that contains dissolved nitrogen dioxide.] | | |
| MW: 63.0 | BP: 181°F | FRZ: -44°F |
| VP: 48 mmHg | IP: 11.95 eV | Sp.Gr(77°F): 1.50 |
| FLP: NA | UEL: NA | LEL: NA |
| Noncombustible Liquid, but increases the flammability of combustible materials. | | |
| Incompatibilities & Reactivities Combustible materials, metallic powders, hydrogen sulfide, carbides, alcohols [Note: Reacts with water to produce heat. Corrosive to metals.] | | |
| Measurement Methods NIOSH 7903; OSHA ID165SG See: NMAM or OSHA Methods | | |
| Personal Protection & Sanitation Skin: Prevent skin contact Eyes: Prevent eye contact Wash skin: When contaminated Remove: When wet or contaminated Change: No recommendation Provide: Eyewash (pH<2.5), Quick drench (pH<2.5) | | First Aid (See procedures) Eye: Irrigate immediately Skin: Water flush immediately Breathing: Respiratory support Swallow: Medical attention immediately |
| Important additional information about respirator selection Respirator Recommendations NIOSH/OSHA Up to 25 ppm: (APF = 25) Any supplied-air respirator operated in a continuous-flow mode*/(APF = 50) Any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern*/(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern*/(APF = 50) Any self-contained breathing apparatus with a full facepiece/(APF = 50) Any supplied-air respirator with a full facepiece Emergency or planned entry into unknown concentrations or IDLH conditions: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode/(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus Escape: (APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern*/Any appropriate escape-type, self-contained breathing apparatus | | |
| Exposure Routes inhalation, ingestion, skin and/or eye contact | | |
| Symptoms Irritation eyes, skin, mucous membrane; delayed pulmonary edema, pneumonitis, bronchitis; dental erosion | | |
| Target Organs Eyes, skin, respiratory system, teeth | | |
| See also: INTRODUCTION See ICSC CARD: 0183 See MEDICAL TESTS: 0158 | | |

NIOSH Pocket Guide to Chemical Hazards

| | | |
|---|---|--|
| Tetrachloroethylene | | CAS 127-18-4 |
| $\text{Cl}_2\text{C}=\text{CCl}_2$ | | RTECS KX3850000 |
| Synonyms & Trade Names Perchloroethylene, Perchloroethylene, Perk, Tetrachlorethylene | | DOT ID & Guide 1897 160 |
| Exposure Limits | NIOSH REL: Ca Minimize workplace exposure concentrations. See Appendix A | |
| | OSHA PEL†: TWA 100 ppm C 200 ppm 300 ppm (5-minute maximum peak in any 3-hours) | |
| IDLH Ca [150 ppm] See: 127184 | | Conversion 1 ppm = 6.78 mg/m ³ |
| Physical Description Colorless liquid with a mild, chloroform-like odor. | | |
| MW: 165.8 | BP: 250°F | FRZ: -2°F |
| VP: 14 mmHg | IP: 9.32 eV | Sp.Gr: 1.62 |
| Fl.P: NA | UEL: NA | LEL: NA |
| Noncombustible Liquid, but decomposes in a fire to hydrogen chloride and phosgene. | | |
| Incompatibilities & Reactivities Strong oxidizers; chemically-active metals such as lithium, beryllium & barium; caustic soda; sodium hydroxide; potash | | |
| Measurement Methods NIOSH 1003; OSHA 1001 See: NMAM or OSHA Methods | | |
| Personal Protection & Sanitation Skin: Prevent skin contact Eyes: Prevent eye contact Wash skin: When contaminated Remove: When wet or contaminated Change: No recommendation Provide: Eyewash, Quick drench | | First Aid (See procedures) Eye: Irrigate immediately Skin: Soap wash promptly Breathing: Respiratory support Swallow: Medical attention immediately |
| Important additional information about respirator selection Respirator Recommendations NIOSH At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode/(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus Escape: (APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister/Any appropriate escape-type, self-contained breathing apparatus | | |
| Exposure Routes inhalation, skin absorption, ingestion, skin and/or eye contact | | |
| Symptoms Irritation eyes, skin, nose, throat, respiratory system; nausea; flush face, neck; dizziness, incoordination; headache, drowsiness; skin erythema (skin redness); liver damage; [potential occupational carcinogen] | | |
| Target Organs Eyes, skin, respiratory system, liver, kidneys, central nervous system | | |
| Cancer Site [in animals: liver tumors] | | |
| See also: INTRODUCTION See ICSC CARD: 0076 See MEDICAL TESTS: 0179 | | |

NIOSH Pocket Guide to Chemical Hazards

| | | |
|---|---|--|
| Trichloroethylene | | CAS 79-01-6 |
| CICH=CCl₂ | | RTECS KX4550000 |
| Synonyms & Trade Names Ethylene trichloride, TCE, Trichloroethene, Trilene | | DOT ID & Guide 1710 160 |
| Exposure Limits | NIOSH REL: Ca See Appendix A See Appendix C | |
| | OSHA PEL†: TWA 100 ppm C 200 ppm 300 ppm (5-minute maximum peak in any 2 hours) | |
| IDLH Ca [1000 ppm] See: 79016 | | Conversion 1 ppm = 5.37 mg/m ³ |
| Physical Description Colorless liquid (unless dyed blue) with a chloroform-like odor. | | |
| MW: 131.4 | BP: 189°F | FRZ: -99°F |
| VP: 58 mmHg | IP: 9.45 eV | Sp.Gr: 1.46 |
| FLP: ? | UEL(77°F): 10.5% | LEL(77°F): 8% |
| Combustible Liquid, but burns with difficulty. | | |
| Incompatibilities & Reactivities Strong caustics & alkalis; chemically-active metals (such as barium, lithium, sodium, magnesium, titanium & beryllium) | | |
| Measurement Methods NIOSH 1022, 3800; OSHA 1001 See: NMAM or OSHA Methods | | |
| Personal Protection & Sanitation Skin: Prevent skin contact Eyes: Prevent eye contact Wash skin: When contaminated Remove: When wet or contaminated Change: No recommendation Provide: Eyewash, Quick drench | | First Aid (See procedures) Eye: Irrigate immediately Skin: Soap wash promptly Breathing: Respiratory support Swallow: Medical attention immediately |
| Important additional information about respirator selection Respirator Recommendations NIOSH At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode/(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus Escape: (APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister/Any appropriate escape-type, self-contained breathing apparatus | | |
| Exposure Routes inhalation, skin absorption, ingestion, skin and/or eye contact | | |
| Symptoms Irritation eyes, skin; headache, visual disturbance, lassitude (weakness, exhaustion), dizziness, tremor, drowsiness, nausea, vomiting; dermatitis; cardiac arrhythmias, paresthesia; liver injury; [potential occupational carcinogen] | | |
| Target Organs Eyes, skin, respiratory system, heart, liver, kidneys, central nervous system | | |
| Cancer Site [in animals: liver & kidney cancer] | | |
| See also: INTRODUCTION See ICSC CARD: 0081 See MEDICAL TESTS: 0236 | | |

[NIOSH Home](#) | [NIOSH Search](#) | [Site Index](#) | [Topic List](#) | [Contact Us](#)

NIOSH Pocket Guide to Chemical Hazards

| | | |
|---|---|--|
| 1,1,2-Trichloroethane | | CAS 79-00-5 |
| CHCl₂CH₂Cl | | RTECS KJ3150000 |
| Synonyms & Trade Names Ethane trichloride, beta-Trichloroethane, Vinyl trichloride | | DOT ID & Guide |
| Exposure Limits | NIOSH REL: Ca TWA 10 ppm (45 mg/m ³) [skin] See Appendix A See Appendix C (Chloroethanes) | |
| | OSHA PEL: TWA 10 ppm (45 mg/m ³) [skin] | |
| IDLH Ca [100 ppm] See: 79005 | | Conversion 1 ppm = 5.46 mg/m ³ |
| Physical Description Colorless liquid with a sweet, chloroform-like odor. | | |
| MW: 133.4 | BP: 237°F | FRZ: -34°F |
| VP: 19 mmHg | IP: 11.00 eV | Sp.Gr: 1.44 |
| Fl.P: ? | UEL: 15.5% | LEL: 6% |
| Combustible Liquid, forms dense soot. | | |
| Incompatibilities & Reactivities Strong oxidizers & caustics; chemically-active metals (such as aluminum, magnesium powders, sodium & potassium) | | |
| Measurement Methods NIOSH 1003; OSHA 11 See: NMAM or OSHA Methods | | |
| Personal Protection & Sanitation Skin: Prevent skin contact Eyes: Prevent eye contact Wash skin: When contaminated Remove: When wet or contaminated Change: No recommendation Provide: Eyewash, Quick drench | | First Aid (See procedures) Eye: Irrigate immediately Skin: Soap wash promptly Breathing: Respiratory support Swallow: Medical attention immediately |
| Important additional information about respirator selection Respirator Recommendations NIOSH At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode/(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus Escape: (APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister/Any appropriate escape-type, self-contained breathing apparatus | | |
| Exposure Routes inhalation, skin absorption, ingestion, skin and/or eye contact | | |
| Symptoms Irritation eyes, nose; central nervous system depression; liver, kidney damage; dermatitis; [potential occupational carcinogen] | | |
| Target Organs Eyes, respiratory system, central nervous system, liver, kidneys | | |
| Cancer Site [in animals: liver cancer] | | |
| See also: INTRODUCTION See ICSC CARD: 0080 See MEDICAL TESTS: 0235 | | |

NIOSH Home | NIOSH Search | Site Index | Topic List | Contact Us

ATTACHMENT B

MATERIAL SAFETY DATA SHEETS

FORM 26

ATTACHMENT C

SAFETY PROCEDURES/FIELD OPERATING PROCEDURES

(FLD OPS)

APPENDIX C

DATA QUALITY INDICATORS

| Table C-1 Action Levels and Contract Required Quantitation Limits for Analytes of Concern EBHH Targeted Brownfields Assessment | | | | | | |
|---|------------------|-------------------------|-----------------|-----------------|----------------|----------------|
| Analyte | Soil | | | Groundwater | | |
| | RBSLs (mg/kg) | PRGs (mg/kg) | CRQL (mg/kg) | RBSLs (µg/l) | ESLs (µg/l) | CRQL (µg/l) |
| Inorganics | | | | | | |
| Asbestos | - | 1% NESHAP | 1% | - | - | na |
| Arsenic | 0.32 | 0.39/ 0.062* | 1.0 | - | 36 | 5 |
| Barium | 5,200 | 5,400 | 1.0 | - | 1000 | 5 |
| Cadmium | 37 | 37 | 0.50 | - | 1.1 | 5 |
| Total Chromium | 74,000 | 210 | 1.0 | - | 180 | 5 |
| Lead | - | 400/150* | 1.0 | - | 2.5 | 5 |
| Mercury | 4.7 | 23 | 0.050 | 260 | 0.012 | 0.2 |
| Selenium | 370 | 390 | 2.0 | - | 5 | 5 |
| Silver | 370 | 390 | 1.0 | - | 0.19 | 5 |
| Polynuclear Aromatic Hydrocarbons | | | | | | |
| Acenaphthene | 3,100 | 3,700 | 0.005 | >SOL | 23 | 0.1 |
| Anthracene | 16,000 | 22,000 | 0.005 | >SOL | 0.73 | 0.1 |
| Benzo (a) anthracene | 0.25 | 0.62 | 0.005 | >SOL | 0.027 | 0.1 |
| Benzo (a) pyrene | 0.025 | 0.062 | 0.005 | >SOL | 0.014 | 0.1 |
| Benzo (b) fluoranthene | 0.25 | 0.62 | 0.005 | >SOL | 0.029 | 0.1 |
| Benzo (k) fluoranthene | 0.25 | 6.2/0.38* | 0.005 | >SOL | 0.4 | 0.1 |
| Chrysene | 2.5 | 62/3.8* | 0.005 | >SOL | 0.35 | 0.1 |
| Dibenzo (a,h) anthracene | 0.074 | 0.062 | 0.005 | >SOL | 0.25 | 0.1 |
| Fluoranthene | 2,100 | 2,300 | 0.005 | >SOL | 8 | 0.1 |
| Fluorene | 2,100 | 2,700 | 0.005 | >SOL | 3.9 | 0.1 |
| Indeno (1,2,3-cd) pyrene | 0.25 | 0.62 | 0.005 | >SOL | 0.029 | 0.1 |
| Naphthalene | 2,000 | 56/1.7* | 0.005 | >SOL | 24 | 0.1 |
| Pyrene | 1,600 | 2,300 | 0.005 | >SOL | 2 | 0.1 |

Table C-1
Action Levels and Contract Required Quantitation Limits for Analytes of Concern
EBHH Targeted Brownfields Assessment

| Analyte | Soil | | | Groundwater | | |
|---------------------------|------------------|-----------------|-----------------|-----------------|----------------|----------------|
| | RBSLs (mg/kg) | PRGs (mg/kg) | CRQL (mg/kg) | RBSLs (µg/l) | ESLs (µg/l) | CRQL (µg/l) |
| Pesticides | | | | | | |
| Aldrin | - | 0.029 | 0.002 | - | 0.13 | 0.06 |
| Chlordane | - | 1.6 | 0.002 | - | 0.004 | 1.0 |
| DDD | - | 2.4 | 0.002 | - | 0.001 | 0.06 |
| DDE | - | 1.7 | 0.002 | - | 0.001 | 0.06 |
| DDT | - | 1.7 | 0.002 | - | 0.001 | 0.06 |
| Dieldrin | - | 0.03 | 0.002 | - | 0.0019 | 0.06 |
| Endosulfan | - | 370 | 0.002 | - | 0.0087 | 0.06 |
| Endrin | - | 18 | 0.002 | - | 0.0023 | 0.06 |
| Heptachlor | - | 0.11 | 0.002 | - | 0.0038 | 0.06 |
| Heptachlor epoxide | - | 0.053 | 0.002 | - | 0.0038 | 0.06 |
| Hexachlorobenzene | - | 0.3 | 0.002 | - | 3.7 | 0.06 |
| Lindane | - | 0.09 | 0.002 | - | 0.08 | 0.06 |
| Methoxychlor | - | 310 | 0.002 | - | 0.019 | 0.06 |
| Toxaphene | - | 0.44 | 0.1 | - | 0.0002 | 1.0 |
| TPH-gasoline/TPH - diesel | 100** | - | 1.0 | - | 500/640 | 50 |
| Benzene | 2.7 | 0.64 | 0.005 | 110 | 46 | 0.5 |
| Toluene | 9,000 | 520 | 0.005 | 210,000 | 130 | 0.5 |
| Ethyl Benzene | 5,100 | 400 | 0.005 | >SOL | 290 | 0.5 |
| Total Xylenes | 54,000 | 270 | 0.005 | >SOL | 100 | 1.0 |
| Tetrachloroethylene (PCE) | na | na | na | 200 | 120 | 0.5 |
| Trichloroethylene (TCE) | na | na | na | 690 | 360 | 0.5 |
| Trichloroethane (TCA) | na | na | na | 990 | 62 | 0.5 |

RBSL = Oakland Tier 1 Risk Based Screening Level (Jan 2001)
PRG = EPA Preliminary Remediation Goal for residential soil (Oct 2004)
NESHAP = National Air Emissions for Hazardous Air Pollutants
CRQL = Contract Required Quantitation Limits
Bold = CRQL exceeds Action Level
ESL = RWQCB Environmental Screening Level
TPH = Total Petroleum Hydrocarbons

mg/kg = milligrams per kilogram
µg/l = micrograms per liter
- = None
* California modified PRG
** = ESL used as no RBSL has been established
na = not applicable
>SOL = RBSL exceeds solubility of chemical in water

Metals (6010/7000s Series)

Table 1A. Summary of Holding Times and Preservation for Metals

| Analytical Parameter ^a | Technical and Contract Holding Times | Preservation |
|-----------------------------------|---|--------------------------|
| Metals in water (except Mercury) | Technical: 180 days from date of collection; Contract: 35 days from sample receipt at laboratory | pH <2 (with nitric acid) |
| Metals in soil (except Mercury) | Technical: 180 days from date of collection; Contract: 35 days from sample receipt at laboratory | Cool to 4°C ±2°C |
| Mercury in water | Technical: 28 days from date of collection; Contract: 26 days from sample receipt at laboratory | pH <2 (with nitric acid) |
| Mercury in soil | Technical: 28 days from date of collection; Contract: 26 days from sample receipt at laboratory | Cool to 4°C ±2°C |

^a Individual target compounds are listed in Table 1B.

Sample Preparation:

Water samples are to be prepared following the protocol presented in SW-846 Method 3010. Soil samples are to be prepared following the protocol presented in SW-846 Method 3050. Analyses to be performed by SW-846 Method 6010: Inductively Coupled Plasma (ICP); SW-846 Method 7000s series: Graphite Furnace Atomic Absorption (GFAA); and SW-846 Method 7470/7471: Mercury Analysis by CVAA.

Data Calculations and Reporting Units:

Calculate the sample results according to the protocol of the appropriate analytical method used.

Report water sample results in concentration units of micrograms per liter (µg/L), and soil sample results in concentrations units of milligrams per kilogram (mg/kg) on a dry weight basis. Report percent solids to the nearest percent.

For rounding results, adhere to the following rules:

- If the number following those to be retained is less than 5, round down;
- If the number following those to be retained is greater than 5, round up; or
- If the number following the last digit to be retained is equal to 5, round down if the digit is even, or round up if the digit is odd.

All records of analysis and calculations must be legible and sufficient to recalculate all sample concentrations and QC results. Include an example calculation in the data package.

TABLE 1B. Target Compound List, CAS Numbers, and Contract Required Detection Limits for Metals

| COMPOUND | CAS No. | CRDL for Water (µg/L) | CRDL for Soil (mg/Kg) |
|-----------|-----------|--------------------------|--------------------------|
| Aluminum | 7429-90-5 | 200 | 40.0 |
| Antimony | 7440-36-0 | 60 | 12.0 |
| Arsenic | 7440-38-2 | 10 | 2.0 |
| Barium | 7440-39-3 | 200 | 40.0 |
| Beryllium | 7440-41-7 | 5 | 1.00 |
| Cadmium | 7440-43-9 | 5 | 1.0 |
| Calcium | 7440-70-2 | 5000 | 1000.0 |
| Chromium | 7440-47-3 | 10 | 2.0 |
| Cobalt | 7440-48-4 | 50 | 10.0 |
| Copper | 7440-50-8 | 25 | 5.0 |
| Iron | 7439-89-6 | 100 | 20.0 |
| Lead | 7439-92-1 | 3 | 0.6 |
| Magnesium | 7439-95-4 | 5000 | 1000 |
| Manganese | 7439-96-5 | 15 | 3 |
| Mercury | 7439-97-6 | 0.2 | 0.04 |
| Nickel | 7440-02-0 | 40 | 8.0 |
| Potassium | 7440-09-7 | 5000 | 1000.0 |
| Selenium | 7782-49-2 | 5 | 1.0 |
| Silver | 7440-22-4 | 10 | 2.0 |
| Sodium | 7440-23-5 | 5000 | 1000.0 |
| Thallium | 7440-28-0 | 10 | 2.0 |
| Vanadium | 7440-62-2 | 50 | 5.0 |
| Zinc | 7440-66-6 | 20 | 4.0 |

Table 2A. Summary of Calibration Procedures for Metals by ICP

| Calibration Element | Frequency | Acceptance Criteria | Corrective Action |
|---|--|---|---|
| Initial Calibration (minimum blank + 1 calibration standard) (ICAL) | Initially, Daily; whenever required, due to failure of CCV | Acceptable ICV, CRDL, and ICB standards | 1. Terminate analysis 2. Re-calibrate and verify before sample analysis |
| Initial Calibration Verification (ICV) at midpoint of ICAL (Different source from ICAL standards) | Daily, immediately following ICAL and prior to sample analysis | ±10% from expected concentration | 1. Terminate analysis and identify and document problem 2. Reprep and re-analyze ICV and all associated samples 3. Re-calibrate and re-analyze reprepped ICV and all associated samples |
| Calibration Blank Verification (ICB, CCB) | After ICV and every CCV | < CRDL | 1. Terminate analysis 2. Determine Source of contamination 3. Reprep ICB and CCB 4. Re-analyze all samples associated with a contaminated blank |
| Continuing Calibration Verification (CCV) | Before samples, after every 10 samples, and end of run | ± 10% from expected concentration | 1. Re-calibrate and verify 2. Re-analyze samples back to last acceptable CCV |
| Contract Required Detection Limit Verification Standard (CRI) | After ICV, but before sample analysis | ±35% from expected concentration | 1. Re-calibrate and verify 2. Re-analyze samples back to last compliant CCV |
| ICP Interference Check Sample (ICS) | Run at start and finish of daily run or twice per 8 hours | ± 20% from true value concentration | 1. Reprep and re-analyze standard 2. Re-calibrate, verify and re-analyze all associated samples |

METALS

Table 2B. Summary of Calibration Procedures for Metals by GFAA

| Calibration Element | Frequency | Acceptance Criteria | Corrective Action |
|---|---|--|--|
| Initial Calibration (minimum blank + 3 standards for each analyte) (ICAL) ^a | Initially, each analytical batch; whenever required, due to failure of CCV | $r \geq 0.995$ | 1. Terminate analysis 2. Re-calibrate and verify before sample analysis |
| Initial Calibration Verification (ICV) at midpoint of ICAL (Different source from ICAL standards) | Daily, immediately following ICAL and prior to sample analysis | $\pm 10\%$ from expected concentration | 1. Terminate analysis and identify and document problem 2. Reprep and re-analyze ICV and all associated samples 3. Re-calibrate and re-analyze repped ICV and all associated samples |
| Calibration Blank Verification (ICB, CCB) | After ICV and every CCV | < CRDL | 1. Terminate analysis 2. Determine Source of contamination 3. Reprep ICB and CCB 4. Re-analyze all samples associated with a contaminated blank |
| Continuing Calibration Verification (CCV) | Following ICV and before sample analysis; after every 10 samples and end of run | $\pm 10\%$ from expected concentration | 1. Re-calibrate and verify 2. Re-analyze samples back to last acceptable CCV |
| Contract Required Detection Limit Verification Standard (CRA) | After ICV, but before sample analysis | $\pm 35\%$ from expected concentration | 1. Reprep and re-analyze standard 2. Re-calibrate and verify |

^a The ICAL low standard must be between the CRDL and 2X CRDL.

Table 2C. Summary of Calibration Procedures for Mercury by CVAA

| Calibration Element | Frequency | Acceptance Criteria | Corrective Action |
|---|--|--|---|
| Initial Calibration (minimum blank + 5 standards) (ICAL) ^a | Initially, each analytical batch; whenever required, due to failure of CCV | $r \geq 0.995$ | 1. Terminate analysis 2. Re-calibrate and verify before sample analysis |
| Initial Calibration Verification (ICV) at midpoint of ICAL (Different source from ICAL standards) | Daily, immediately following ICAL and prior to sample analysis | $\pm 20\%$ from expected concentration | 1. Terminate analysis and identify and document problem 2. Reprep and re-analyze ICV and all associated samples 3. Re-calibrate and re-analyze reprepped ICV and all associated samples |
| Calibration Blank Verification (ICB, CCB) | After ICV and every CCV | $< \text{CRDL}$ | 1. Terminate analysis 2. Determine Source of contamination 3. Reprep ICB and CCB 4. Re-analyze all samples associated with a contaminated blank |
| Continuing Calibration Verification (CCV) | Before Samples, after every 10 samples, and end of run | $\pm 20\%$ from expected concentration | 1. Re-calibrate and verify 2. Re-analyze samples back to last acceptable CCV |
| Contract Required Detection Limit Verification Standard (CRA) | After ICV, but before sample analysis | $\pm 35\%$ from expected concentration | 1. Reprep and re-analyze standard 2. Re-calibrate and verify |

^a The ICAL low standard must be at the CRDL.

Table 3. Summary of Internal Quality Control Procedures for Metals by ICP, CVAA, and CFAA

| QC Element | Frequency | Acceptance Criteria | Corrective Action |
|--|--------------------------------------|--|---|
| Method Blank (MB) | One per batch or SDG ^{a, b} | < CRDL | <ol style="list-style-type: none"> 1. If lowest sample concentration is more than 10X the blank conc., no action 2. If samples are non-detected, no action 3. If detected sample concentrations are less than 10X blank conc., all affected samples must be prepared again with another method blank and re-analyzed |
| Duplicate Sample (DUP) | One per batch or SDG ^{a, b} | Waters: RPD $\leq \pm 20\%$ for samples $> 5X$ CRDL; \pm CRDL for samples $< 5X$ CRDL Soils: RPD $\leq \pm 35\%$ for samples $> 5X$ CRDL; $\pm 2x$ CRDL for samples $< 5X$ CRDL | 1. Flag associated data with an "*" |
| Matrix Spike Sample (MS) | One per batch or SDG ^{a, b} | $\pm 25\%$ from expected value ^c | 1. Flag associated data with an "N" |
| Laboratory Control Sample (LCS) | One per batch or SDG ^{a, b} | Waters: $\pm 20\%$ from expected concentration Soils: within control limits of certified solid LCS or $\pm 20\%$ from expected spike concentration | <ol style="list-style-type: none"> 1. Terminate analysis and identify and document the problem 2. Re-analyze all associated samples |
| Serial Dilution Sample (5 X Dilution) (ICP only) | One per batch or SDG ^{a, b} | $\pm 10\%$ difference from original results for analytes greater than 50 X IDL | 1. Flag associated data with a "B" |

Table 3. (cont) Summary of Internal Quality Control Procedures for Metals by ICP, CVAA, and GFAA

| QC Element | Frequency | Acceptance Criteria | Corrective Action |
|--|--|--|--|
| Duplicate Injections (GFAA only) | All samples | Duplicate results within $\pm 20\%$ RPD (or CV) | 1. Rerun sample once 2. Flag associated data with an "E" if acceptance criteria are not met after second run |
| Analytical Spike Sample (2 X CRDL) (GFAA only) | All samples | Spike recovery $\pm 15\%$ | 1. If spike recovery is $<40\%$, dilute sample by a factor of 5 to 10 and run again. If recovery is still $<40\%$, report data and flag with an "E" to indicate interference problems 2. If sample concentration is $<50\%$ of recovered spike value and spike recovery is $>40\%$ and $<85\%$ or $>115\%$, report result down to IDL and flag result with a "W" 3. If sample concentration is $>50\%$ of recovered spike value and spike recovery is $>40\%$ and $<85\%$ or $>115\%$, quantitate by MSA |
| Method of Standard Addition (GFAA only) | As determined by analytical spike recovery results | 3 samples spiked at 50%, 100%, and 150% of sample concentration and $r \geq 0.995$ | 1. Rerun samples only once 2. Flag associated data with a "+" if acceptance criteria are not met after second run |

^a SDG - Sample Delivery Group - each case of field samples received; or each 20 field samples within a case; or each 14 calendar day period during which field samples in a case are received.

^b Minimum requirement is the analysis of 1 QC sample per 20 samples.

^c An exception to this rule is granted in situations where the sample concentration exceeds the spike concentration by a factor of 4. In such an event, the data shall be reported unflagged.

Dilute and reanalyze samples with concentrations exceeding the range of the calibration curve. Results for such re-analyses should fall within the mid-range of the calibration curve. Report results and submit documentation for both analyses.

TOTAL PETROLEUM HYDROCARBONS (TPH) as Gasoline and Diesel

SW-846 Method 8015B (Revision 2, December 1996)

Table 1A. Summary of Contract Required Quantitation Limits, Holding Times, and Preservation for Total Petroleum Hydrocarbons (TPH) as Gasoline and Diesel

| Analytical Parameter ^a | Technical and Contract Holding Times | Preservation |
|---|--|--|
| Total Petroleum Hydrocarbons (TPH) as Gasoline in Water Samples | <u>Technical</u> : 7 days from collection; <u>Contract</u> : 5 days from receipt at laboratory | Cool to 4°C ±2°C |
| TPH as Gasoline in Water Samples | <u>Technical</u> : 14 days from collection; <u>Contract</u> : 10 days from receipt at laboratory | HCl or H ₂ SO ₄ to pH<2; Cool to 4°C ±2°C |
| TPH as Gasoline in Soil Samples | <u>Technical</u> : 48 hours <u>Contract</u> : 48 hours | Cool to 4°C ±2°C; sealed zero headspace containers; freezing can extend the holding time ^{b,c} |
| TPH as Gasoline in Soil Samples | <u>Technical</u> : 14 days from collection; <u>Contract</u> : 10 days from receipt at laboratory | Preserved samples: in methanol ^d or sodium bisulfate ^e |
| TPH as Diesel in Water Samples | <u>Technical to Extraction</u> : 14 days from collection; <u>Contract to Extraction</u> : 10 days from receipt at laboratory <u>Technical and Contract to Analysis</u> : 40 days from extraction | Cool to 4°C ±2°C; HCl or H ₂ SO ₄ to pH<2 ^f |
| TPH as Diesel in Soil Samples | <u>Technical to Extraction</u> : 14 days from collection; <u>Contract to Extraction</u> : 10 days from receipt at laboratory <u>Technical and Contract to Analysis</u> : 40 days from extraction | Cool to 4°C ±2°C |

^a Individual target compounds are listed in Table 1B.

^b Freezing the sample can extend the holding time; however, 48 hours unfrozen holding time will be considered cumulative.

^c Use Method 5021 for headspace analysis.

^d Use Method 5030 for purge and trap.

^e Use Method 5035 for purge and trap.

^f Diesel analysis does not require acidification; however, acidified samples can be analyzed for diesel.

Data Calculations and Reporting Units:

Calculate the sample results using calibration factors determined according to Sections 7.7.2 of Method 8015B and 7.4.2 and 7.8.1 of SW-846 Method 8000A.

Report water sample results in concentration units of milligrams per liter (mg/L). Report soil sample results on a dry-weight basis in milligrams per kilogram (mg/kg).

For rounding results, adhere to the following rules:

- a) If the number following those to be retained is less than 5, round down;
- b) If the number following those to be retained is greater than 5, round up; or
- c) If the number following the last digit to be retained is equal to 5, round down if the digit is even, or round up if the digit is odd.

All records of analysis and calculations must be legible and sufficient to recalculate all sample concentrations and QC results. Include an example calculation in the data package.

TABLE 1B. Target Compound List and Contract Required Detection Limits (CRQL) for SW-846 Method 8015B

| COMPOUND | CRQL Water mg/L | CRQL Soil mg/kg |
|---------------------------|--------------------|--------------------|
| Gasoline - Purge and Trap | 0.5 | 10 |
| Gasoline - Headspace | 5.0 | 5 |
| Diesel | 0.5 | 10 |

Table 2. Summary of Calibration Procedures for Total Petroleum Hydrocarbons (TPH) as Gasoline and Diesel by SW-846 Method 8015B

| Calibration Element | Frequency | Acceptance Criteria | Corrective Action |
|---|--|---|--|
| Initial Calibration (minimum blank + 5 points for each analyte) (ICAL) ^{a, b, c} | Initially; whenever required, due to failure of CCV | RSD for CFs $\leq 20\%$; or, if using a linear calibration curve, a correlation coefficient (r) of ≥ 0.99 for each compound | 1. Terminate analysis 2. Re-calibrate and verify before sample analysis |
| Continuing Calibration Verification (CCV) at midpoint of ICAL | Beginning of each 12 hour time period, after every 10 samples and end of run | %D between calculated amount and nominal amount within $\pm 25\%$ | 1. Re-calibrate and verify 2. Re-analyze samples back to last good CCV |
| Retention time evaluation CCV standards | Each analysis of CCV standards | $\pm 3 \times$ the SD of the avg ICAL RT for surrogate, See footnote ^c for GRO and DRO | 1. Re-calibrate and verify 2. Re-analyze samples back to last good IPC |

^a The ICAL low standard must be above but near the CRQL. The low ICAL standard must have a signal to noise ratio $\geq 5:1$. If this requirement cannot be met, the laboratory must submit a MDL study as part of the data package.

^b Gasoline Range Organics (GRO): C_6-C_{10} ; Diesel Range Organics (DRO): $C_{10}-C_{28}$

^c Establish and report retention time (RT) windows for GRO and DRO as described in Section 7.4 of Method 8015B and 7.6 of Method 8000B. Calculate RT windows for GRO and DRO based on the lower limit of the RT window for the first eluting component and the upper limit of the RT window for the last eluting component. Determine RT windows for surrogate compounds as $\pm 3 \times$ the standard deviation (SD) of the average ICAL RT for each analyte.

Table 3. Summary of Internal Quality Control Procedures for Total Petroleum Hydrocarbons (TPH) as Gasoline and Diesel by SW-846 Method 8015B

| QC Element | Frequency | Acceptance Criteria | Corrective Action |
|-------------------------------------|--|---|---|
| Method Blank (MB) | Gasoline: One per each 12 hour time period and after unusually concentrated samples Diesel: One per Batch or SDG ^a (1 per 20 samples minimum) and for each instrument used | < CRQL for each compound | 1. Investigate source of contamination and document corrective action measures 2. Re-extract and re-analyze all samples processed with a method blank that is out-of-control |
| Surrogate Spike ^b | Every sample and MB at midpoint of calibration range | Water Samples: 75-125% of expected value Soil Samples: 60-125% of expected value | 1. Re-analyze all samples with non-compliant surrogate recoveries |
| Matrix Spike and Duplicate (MS/MSD) | One MS/MSD set per batch or SDG (1 MS/MSD set per 20 samples minimum) | 65-135% of expected value; ≤30 RPD between MS and MSD | 1. Report in case narrative |
| Laboratory Control Sample (LCS) | Gasoline: one each 12-hour period; Diesel: one per Batch or SDG | 80-120% of expected value | 1. Re-extract and re-analyze all samples processed with out-of-control LCS |

^a SDG - Sample Delivery Group - each case of field samples received; or each 20 field samples within a case; or each 14 calendar day period during which field samples in a case are received.

^b Surrogates for GRO: 4-bromofluorobenzene and 1,1,1-trifluorotoluene;
Surrogate for DRO: hexacosane or ortho-terphenyl

Dilute and reanalyze samples with one or more analytes at concentrations exceeding the range of the calibration curve. Results for such reanalyses should fall within the mid-range of the calibration curve. Report results and submit documentation for both analyses.

ORGANOCHLORINE PESTICIDES AND POLYCHLORINATED BIPHENYLS (PCBs)

SW-846 Method 8081 or 8080

Table 1A. Summary of Holding Times and Preservation for Organochlorine Pesticides and Polychlorinated Biphenyls (PCBs)

| Analytical Parameter ^a | Technical and Contract Holding Times | Preservation |
|---|--|------------------|
| Organochlorine Pesticides and Polychlorinated Biphenyls (PCBs) in Water Samples | <u>Technical for Extraction:</u> 7 days from collection; <u>Contract for Extraction:</u> 5 days from receipt at laboratory <u>Technical and Contract for Analysis:</u> 40 days from extraction | Cool to 4°C ±2°C |
| Organochlorine Pesticides and Polychlorinated Biphenyls (PCBs) in Soil Samples | <u>Technical for Extraction:</u> 14 days from collection; <u>Contract for Extraction:</u> 10 days from receipt at laboratory <u>Technical and Contract for Analysis:</u> 40 days from extraction | Cool to 4°C ±2°C |

^a Individual target compounds are listed in Table 1B.

Data Calculations and Reporting Units:

Calculate the calibration factors (CF) of single component pesticides according to Section 7.4.2 of SW-846 Method 8000A. Calculate sample results using the analyte CFs from the midpoint standard of the associated initial calibration curve. Perform sample quantitation for multiple components pesticides according to Section 7.6 of SW-846 Method 8080A or 8081.

Report water sample results in concentration units of micrograms per liter (µg/L). Report soil sample results on a dry-weight basis in micrograms per kilogram (µg/kg).

For rounding results, adhere to the following rules:

- a) If the number following those to be retained is less than 5, round down;
- b) If the number following those to be retained is greater than 5, round up; or
- c) If the number following the last digit to be retained is equal to 5, round down if the digit is even, or round up if the digit is odd.

All records of analysis and calculations must be legible and sufficient to recalculate all sample concentrations and QC results. Include an example calculation in the data package.

TABLE 1B. Target Compound List, CAS Numbers, and Contract Required Quantitation Limits (CRQL) for SW-846 Method 8081 or Method 8080

| COMPOUND | CAS No. | CRQL Water µg/L | CRQL Soil µg/kg |
|---------------------|------------|--------------------|--------------------|
| alpha-BHC | 319-84-6 | 0.05 | 2 |
| beta-BHC | 319-85-7 | 0.05 | 2 |
| delta-BHC | 319-86-8 | 0.05 | 2 |
| gamma-BHC (Lindane) | 58-89-9 | 0.05 | 2 |
| Heptachlor | 76-44-8 | 0.05 | 2 |
| Aldrin | 309-00-2 | 0.05 | 2 |
| Heptachlor epoxide | 1024-57-3 | 0.05 | 2 |
| Endosulfan I | 959-98-8 | 0.05 | 2 |
| Dieldrin | 60-57-1 | 0.1 | 3 |
| 4,4'-DDE | 72-55-9 | 0.1 | 3 |
| Endrin | 72-20-8 | 0.1 | 3 |
| Endosulfan II | 33213-65-9 | 0.1 | 3 |
| 4,4'-DDD | 72-54-8 | 0.1 | 3 |
| Endosulfan sulfate | 1031-07-8 | 0.1 | 3 |
| 4,4'-DDT | 50-29-3 | 0.1 | 3 |
| Methoxychlor | 72-43-5 | 0.5 | 17 |
| Endrin ketone | 53494-70-5 | 0.1 | 3 |
| Endrin aldehyde | 7421-93-4 | 0.1 | 3 |
| alpha-Chlordane | 5103-71-9 | 0.05 | 2 |
| gamma-Chlordane | 5103-74-2 | 0.05 | 2 |
| Toxaphene | 8001-35-2 | 5 | 170 |
| Aroclor-1016 | 12674-11-2 | 1 | 33 |
| Aroclor-1221 | 11104-28-2 | 2 | 67 |
| Aroclor-1232 | 11141-16-5 | 1 | 33 |
| Aroclor-1242 | 53469-21-9 | 1 | 33 |
| Aroclor-1248 | 12672-29-6 | 1 | 33 |
| Aroclor-1254 | 11097-69-1 | 1 | 33 |
| Aroclor-1260 | 11096-82-5 | 1 | 3 |

Table 2. Summary of Calibration Procedures for Organochlorine Pesticides and Polychlorinated Biphenyls (PCBs) by SW-846 Method 8081 or 8080

| Calibration Element | Frequency | Acceptance Criteria | Corrective Action |
|---|---|---|---|
| Initial Calibration (minimum blank + 3 points for each analyte) (ICAL) ^{a, b, c} | Initially; whenever required, due to failure of CCV | RSD for CFS $\leq 20\%$ ($\leq 30\%$ for Surrogate compounds) | 1. Terminate analysis 2. Re-calibrate and verify before sample analysis |
| Continuing Calibration Verification (CCV) at midpoint of ICAL | Beginning of each day, after every 10 samples, and end of run | %D between CF of CCV and avg CFS from ICAL $\leq 25\%$ | 1. Re-calibrate and verify 2. Re-analyze samples back to last good CCV |
| Endrin and 4,4'-DDT Breakdown | Beginning and end of analytical sequence | $\leq 20\%$ each or $\leq 30\%$ combined | 1. Investigate source of the problem and document 2. If either Endrin, 4,4'-DDT, or their breakdown products were detected, re-analyze the samples |

^a The ICAL low standard must be above but near the CRQL. The low ICAL standard must have a signal to noise ratio $\geq 5:1$. If this requirement cannot be met, the laboratory must submit a MDL study as part of the data package.

^b ICAL Prepare initial calibration individual standard mixtures A and B (IND A and IND B) containing the single component pesticides specified in Table 9 of SW-846 Method 8081 at three concentration levels. For multiple response pesticides, including toxaphene and Aroclors (except 1016 and 1260), prepare separate initial calibration standards at the following concentration levels: Aroclors (except 1221) at 100 ng/mL; Aroclor-1221 at 200 ng/mL; and toxaphene at 500 ng/mL. Aroclor-1016 and Aroclor-1260 may be combined into a single standard solution. Spike all calibration standards with the surrogate compounds discussed in Table 3 at a concentration of 20 ng/mL.

^c Report the retention time window for each analyte. For multiple component pesticides, calculate the retention time window for 5 major peaks from the initial calibration standard analysis.

Determine retention time windows for both single and multiple component pesticides using the following guidelines:

| <u>Column Type</u> | Retention Time Window in Minutes |
|--|--|
| Packed Column | ± 2% |
| Mega bore or wide bore capillary column | . ±0.05 for tetrachloro-m-xylene through Aldrin . ±0.07 for compounds which elute after Aldrin . ±0.1 for decachlorobiphenyl |

Table 3. Summary of Internal Quality Control Procedures for Organochlorine Pesticides and Polychlorinated Biphenyls (PCBs) by SW-846 Method 8081 or 8080

| QC Element | Frequency | Acceptance Criteria | Corrective Action |
|---|---|---|---|
| Method Blank (MB) | One per Batch or SDG ^a (1 per 20 samples minimum) | < CRQL for each compound | 1. Investigate source of contamination and document 2. Re-extract and re-analyze all samples processed with a non-compliant method blank |
| Surrogate ^b | Every standard, sample, method blank and QC sample at 10 times CRQL | 60-150% of expected value | 1. Re-analyze all samples with non-compliant surrogate recoveries |
| Matrix Spike and Matrix Spike Duplicate (MS/MSD) ^c | One MS/MSD set per batch or SDG (1 MS/MSD set per 20 samples minimum) | 50-135% of expected value; ≤ 30 RPD between MS and MSD | 1. Address in narrative |

^a SDG - Sample Delivery Group - each case of field samples received; or each 20 field samples within a case; or each 14 calendar day period during which field samples in a case are received.

^b Spike each standard, sample, and blank with 1mL of a solution containing 0.2 μ g/mL each of tetrachloro-m-xylene and decachlorobiphenyl

^c Spike MS/MSD samples with 1mL of a solution containing the following compounds and levels:

| Target compound | Concentration (μ g/mL) | Target Compound | Concentration (μ g/mL) |
|-----------------|-----------------------------|-----------------|-----------------------------|
| ?-BHC | 0.5 | Heptachlor | 0.5 |
| 4,4'-DDT | 1.0 | Aldrin | 0.5 |
| Endrin | 1.0 | Dieldrin | 1.0 |

Dilute and re-analyze samples with one or more analytes at concentrations exceeding the range of the calibration curve. Results for such re-analyses should fall within the mid-range of the calibration curve. Report results and submit documentation for both analyses.

Second column confirmation is required for all positive results. Perform confirmation analyses on a column of a phase different from that used for quantitation. Confirmation analyses must meet all instrument calibration criteria and blank acceptance criteria specified in Table 2, above.

VOLATILE ORGANIC COMPOUNDS (VOCs)

SW-846 Method 8260

Table 1A. *Summary of Holding Times and Preservation for Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry*

| Analytical Parameter ^a | Technical and Contract Holding Times | Preservation |
|--|---|---|
| Volatile Organic Compounds (VOCs) in Water | <u>Technical</u> : 7 days from collection; <u>Contract</u> : 5 days from receipt at laboratory | Cool to 4°C ±2°C; |
| VOCs in Water | <u>Technical</u> : 14 days from collection; <u>Contract</u> : 10 days from receipt at laboratory | HCl to pH <2; Cool to 4°C ±2°C |
| VOCs in Soil | <u>Technical</u> : 48 hours <u>Contract</u> : 48 hours | Cool to 4°C ±2°C; sealed zero headspace containers; freezing can extend the holding time ^b |
| VOCs in Soil | <u>Technical</u> : 14 days from collection; <u>Contract</u> : 10 days from receipt at laboratory | Preserved samples: in methanol ^c or sodium bisulfate ^d |

^a Individual target compounds are listed in Table 1B.

^b Freezing the sample can extend the holding time; however, 48 hours unfrozen holding time will be considered cumulative.

^c Use Method 5030 for purge and trap.

^d Use Method 5035 for purge and trap.

Data Calculations and Reporting Units:

Calculate the response factor (RF) and the concentration of individual analytes according to the equations specified in Sections 7.3.4 of Method 8260. Report water sample results in concentration units of micrograms per liter (µg/L).

Report soil sample results on a dry-weight basis in micrograms per kilogram (µg/kg). Report percent solid and percent moisture to the nearest whole percentage point.

For rounding results, adhere to the following rules:

- a) If the number following those to be retained is less than 5, round down;
- b) If the number following those to be retained is greater than 5, round up; or
- c) If the number following the last digit to be retained is equal to 5, round down if the digit is even, or round up if the digit is odd.

All records of analysis and calculations must be legible and sufficient to recalculate all sample concentrations and QC results. Include an example calculation in the data package.

Table 1B. Target Compound List, CAS Numbers, and Contract Required Quantitation Limits for Volatile Organic Compounds by Method 8260

| <u>Analyte</u> | <u>CAS Number</u> | <u>CRQL $\mu\text{g/L}^a$</u> | <u>CRQL $\mu\text{g/Kg}^b$</u> |
|-----------------------------|-------------------|--|---|
| Benzene | 71-43-2 | 1 | 5 |
| Bromobenzene | 108-86-1 | 1 | 5 |
| Bromochloromethane | 74-97-5 | 1 | 5 |
| Bromodichloromethane | 75-27-4 | 1 | 5 |
| Bromoform | 75-25-2 | 1 | 5 |
| Bromomethane | 74-83-9 | 1 | 5 |
| n-Butylbenzene | 104-51-8 | 1 | 5 |
| sec-Butylbenzene | 135-98-8 | 1 | 5 |
| tert-Butylbenzene | 98-06-6 | 1 | 5 |
| Carbon tetrachloride | 56-23-5 | 1 | 5 |
| Chlorobenzene | 108-90-7 | 1 | 5 |
| Chlorodibromomethane | 124-48-1 | 1 | 5 |
| Chloroethane | 75-00-3 | 1 | 5 |
| Chloroform | 67-66-3 | 1 | 5 |
| Chloromethane | 74-87-3 | 1 | 5 |
| 2-Chlorotoluene | 95-49-8 | 1 | 5 |
| 4-Chlorotoluene | 106-43-4 | 1 | 5 |
| 1,2-Dibromo-3-chloropropane | 96-12-8 | 1 | 5 |
| 1,2-Dibromoethane | 106-93-4 | 1 | 5 |
| Dibromomethane | 74-95-3 | 1 | 5 |
| 1,2-Dichlorobenzene | 95-50-1 | 1 | 5 |
| 1,3-Dichlorobenzene | 541-73-1 | 1 | 5 |
| 1,4-Dichlorobenzene | 106-46-7 | 1 | 5 |
| Dichlorodifluoromethane | 75-71-8 | 1 | 5 |
| 1,1-Dichloroethane | 75-34-3 | 1 | 5 |
| 1,2-Dichloroethane | 107-06-2 | 1 | 5 |
| 1,1-Dichloroethene | 75-35-4 | 1 | 5 |
| cis-1,2-Dichloroethene | 156-59-2 | 1 | 5 |
| trans-1,2-Dichloroethene | 156-60-5 | 1 | 5 |

| | | | |
|---------------------------|-----------|---|---|
| 1,2-Dichloropropane | 78-87-5 | 1 | 5 |
| 2,2-Dichloropropane | 594-20-7 | 1 | 5 |
| 1,3-Dichloropropane | 142-28-9 | 1 | 5 |
| 1,1-Dichloropropene | 563-58-6 | 1 | 5 |
| Ethylbenzene | 100-41-4 | 1 | 5 |
| Hexachlorobutadiene | 87-68-3 | 1 | 5 |
| Isopropylbenzene | 98-82-8 | 1 | 5 |
| p-Isopropyltoluene | 99-87-8 | 1 | 5 |
| Methylene chloride | 75-09-2 | 1 | 5 |
| Naphthalene | 91-20-3 | 1 | 5 |
| n-Propylbenzene | 103-65-1 | 1 | 5 |
| Styrene | 100-42-5 | 1 | 5 |
| 1,1,1,2-Tetrachloroethane | 630-20-6 | 1 | 5 |
| 1,1,2,2-Tetrachloroethane | 79-34-5 | 1 | 5 |
| Tetrachloroethene | 127-18-4 | 1 | 5 |
| Toluene | 108-88-3 | 1 | 5 |
| 1,2,4-Trichlorobenzene | 120-82-1 | 1 | 5 |
| 1,2,3-Trichlorobenzene | 87-61-6 | 1 | 5 |
| 1,1,1-Trichloroethane | 71-55-6 | 1 | 5 |
| 1,1,2-Trichloroethane | 79-00-5 | 1 | 5 |
| Trichloroethene | 79-01-6 | 1 | 5 |
| Trichlorofluoromethane | 75-69-4 | 1 | 5 |
| 1,2,3-Trichloropropane | 96-18-4 | 1 | 5 |
| 1,2,4-Trimethylbenzene | 95-63-6 | 1 | 5 |
| 1,3,5-Trimethylbenzene | 108-67-8 | 1 | 5 |
| Vinyl chloride | 75-01-4 | 1 | 5 |
| o-Xylene | 95-47-6 | 1 | 5 |
| m-Xylene | 108-38-3 | 1 | 5 |
| p-Xylene | 106-42-3 | 1 | 5 |
| Methyl-t-butyl ether | 163-40-44 | 1 | 5 |
| Dichlorofluoromethane | 75-43-4 | 1 | 5 |

^a Based on 25 mL water purge. ^b Based on wet weight

Table 2. Summary of Calibration Procedures for VOCs by SW-846 Method 8260

| Calibration Element | Frequency | Acceptance Criteria | Corrective Action |
|---|--|--|---|
| GC/MS Tuning with BFB | Beginning of each 12 hour period during which standards samples are analyzed | Ion abundance criteria in Table 4 of Method 8260 | 1. Identify the problem. 2. MS tune criteria must be met before any calibration standards, samples, blanks, or QC samples are analyzed |
| Initial Calibration (minimum blank + 5 points for each analyte) ^{a, b, c} (ICAL) | Initially; whenever required, due to failure of CCV | RSD for RFs $\leq 20\%$; | 1. Terminate analysis 2. Recalibrate and verify before sample analysis |
| Continuing Calibration Verification (CCV) | Following ICV, every 12-hour, and end of run | %D between RF of CCV and avg RFs from ICAL $\pm 15\%$ | 1. Recalibrate and verify 2. Reanalyze samples back to last good CCV |
| System Performance Check Compound (SPCC) | With ICAL or CCV | RF for chloromethane, 1,1-dichloroethane, bromoform, ≥ 0.10 ; chlorobenzene, 1,1,2,2-tetrachloroethane, ≥ 0.30 | 1. Terminate analysis 2. Recalibrate and verify before sample analysis |
| Calibration Check Compounds (CCC) | With ICAL or CCV | RSD for RFs $\pm 30\%$ | 1. Terminate analysis 2. Recalibrate and verify before sample analysis |
| Internal Standards | Each analysis of CCV | -50 to +100% | 1. Re-analyze all samples analyzed while system was out-of-control |
| Retention time evaluation of CCV standards | Each analysis of CCV standard | $\pm 3 \times$ the SD of the avg ICAL RT for each analyte | 1. Re-calibrate and verify 2. Re-analyze samples back to last good CCV |

^a The ICAL low standard must be above but near the CRQL. The low ICAL standard must have a signal to noise ratio $\geq 5:1$. If this requirement cannot be met, the laboratory must submit a MDL study as part of the data package.

^b ICAL and continuing CAL standards must contain all target analytes listed in Table 1B.

^c Report the retention time window for each analyte. Determine retention time windows as $\pm 3 \times$ the standard deviation of the average initial calibration retention time for each analyte.

Table 3. Summary of Internal Quality Control Procedures for VOCs by SW-846 Method 8260

| QC Element | Frequency | Acceptance Criteria | Corrective Action |
|--|---|---|---|
| Method Blank (MB) | Each 12-hour time period, minimum of one per SDG ^a | < CRQL for each compound | 1. Investigate the source of contamination and document. 2. Reanalyze all samples processed with a blank that is out of control. |
| Matrix Spike and Matrix Spike Duplicate (MS/MSD) | One MS/MSD set per batch or SDG (1 MS/MSD set per 20 samples minimum) | <u>Water Sample:</u> 65-135% of expected value; $\pm 30\%$ RPD between MS and MSD <u>Soil Sample:</u> 50-150% of expected value; $\pm 50\%$ RPD between MS and MSD | 1. Report in case narrative |
| Surrogate Spikes: ^b | Every sample, standard and method blank | <u>Water Sample:</u> 85-115% except for 1,2-dichloroethane (75-115%) of expected value <u>Soil Sample:</u> 70-125% of expected value | 1. Reanalyze all samples with non-compliant surrogate recoveries |
| Laboratory Control Sample (LCS) | One per SDG | <u>Water Sample:</u> 70-130% of expected value <u>Soil Sample:</u> 65-135% of expected value | 1. Investigate the source of problem and document. 2. Reanalyze all samples processed with a LCS that is out of control. |

^a SDG - Sample Delivery Group - each case of field samples received; or each 20 field samples within a case; or each 14 calendar day period during which field samples in a case are received.

^b Toluene-d₈, BFB, 1,2-dichloroethane-d₄, and Dibromofluoromethane

Dilute and reanalyze samples which contain one or more target analytes at concentrations above the initial calibration range. Results for such reanalyses should fall within the mid-range of the calibration curve. Report results and submit documentation for both analyses.

SEMIVOLATILE ORGANIC COMPOUNDS (SVOCs)

SW-846 Method 8270

Table 1A. Summary of Holding Times and Preservation for Semivolatile Organic Compounds by Gas Chromatography/Mass Spectrometry

| Analytical Parameter ^a | Technical and Contract Holding Times | Preservation |
|---|---|-------------------|
| Semivolatile Organic Compounds (SVOCs) in Water | <u>Technical for Extraction:</u> 14 days from collection; <u>Contract for Extraction:</u> 10 days from receipt at laboratory; <u>Technical and Contract for Analysis:</u> 40 days from extraction | Cool to 4°C ±2°C; |
| SVOCs in Soil ^b | <u>Technical for Extraction:</u> 14 days from collection; <u>Contract for Extraction:</u> 10 days from receipt at laboratory; <u>Technical and Contract for Analysis:</u> 40 days from extraction | Cool to 4°C ±2°C |

^a Individual target compounds are listed in Table 1B.

^b Perform initial sample analysis using a 2-gram sample for mid-level analysis and a 30-gram sample for low-level analysis

Data Calculations and Reporting Units:

Use the mean RRF from the initial calibration to calculate the concentration of individual analytes according to Section 7.7.2 of EPA Method 8270C, Revision 3.0.

Report water sample results in concentration units of micrograms per liter (µg/L). Report soil sample results on a dry-weight basis in micrograms per kilogram (µg/kg). Report percent solid and percent moisture to the nearest whole percentage point.

For rounding results, adhere to the following rules:

- a) If the number following those to be retained is less than 5, round down;
- b) If the number following those to be retained is greater than 5, round up; or
- c) If the number following the last digit to be retained is equal to 5, round down if the digit is even, or round up if the digit is odd.

All records of analysis and calculations must be legible and sufficient to recalculate all sample concentrations and QC results. Include an example calculation in the data package.

Table 1B: Target Compound List and Contract Required Quantitation Limits (CRQLs) for Semivolatile Organic Compounds (SVOCs) by SW-846 Method 8270

| Analyte | Contract Required Quantitation Limits | |
|-------------------------------|---------------------------------------|--------------|
| | Water (µg/L) | Soil (mg/kg) |
| 1,2-Dichlorobenzene | 10 | 0.33 |
| 1,2,4-Trichlorobenzene | 10 | 0.33 |
| 1,3-Dichlorobenzene | 10 | 0.33 |
| 1,4-Dichlorobenzene | 10 | 0.33 |
| 2-Chloronaphthalene | 10 | 0.33 |
| 2-Chlorophenol | 10 | 0.33 |
| 2-Methylnaphthalene | 10 | 0.33 |
| 2-Methylphenol | 10 | 0.33 |
| 2-Nitroaniline | 25 | 0.8 |
| 2-Nitrophenol | 10 | 0.33 |
| 2,2'-oxybis (1-Chloropropane) | 10 | 0.33 |
| 2,4-Dichlorophenol | 10 | 0.33 |
| 2,4-Dimethylphenol | 10 | 0.33 |
| 2,4-Dinitrophenol | 25 | 0.8 |
| 2,4-Dinitrotoluene | 10 | 0.33 |
| 2,4,5-Trichlorophenol | 25 | 0.8 |
| 2,4,6-Trichlorophenol | 10 | 0.33 |
| 2,6-Dinitrotoluene | 10 | 0.33 |
| 3-Nitroaniline | 25 | 0.8 |
| 3,3'-Dichlorobenzidine | 10 | 0.33 |
| 4-Bromophenyl-phenylether | 10 | 0.33 |
| 4-Chloro-3-methylphenol | 10 | 0.33 |
| 4-Chloroaniline | 10 | 0.33 |
| 4-Chlorophenyl-phenyl ether | 10 | 0.33 |
| 4-Methylphenol | 10 | 0.33 |
| 4-Nitroaniline | 25 | 0.8 |
| 4-Nitrophenol | 25 | 0.8 |
| 4,6-Dinitro-2-methylphenol | 25 | 0.8 |
| Acenaphthene | 10 | 0.33 |
| Acenaphthylene | 10 | 0.33 |
| Anthracene | 10 | 0.33 |
| Benzo(a)anthracene | 10 | 0.33 |
| Benzo(a)pyrene | 10 | 0.33 |
| Benzo(b)fluoranthene | 10 | 0.33 |
| Benzo(g,h,i)perylene | 10 | 0.33 |
| Benzo(k)fluoranthene | 10 | 0.33 |
| bis(2-Chloroethoxy)-methane | 10 | 0.33 |
| bis(2-Chloroethyl) ether | 10 | 0.33 |

Table 1B: Target Compound List and Contract Required Quantitation Limits (CRQLs) for Semivolatile Organic Compounds (SVOCs) by SW-846 Method 8270

| Analyte | Contract Required Quantitation Limits | |
|----------------------------|---------------------------------------|--------------|
| | Water (µg/L) | Soil (mg/kg) |
| bis(2-Ethylhexyl)phthalate | 10 | 0.33 |
| Butylbenzylphthalate | 10 | 0.33 |
| Carbazole | 10 | 0.33 |
| Chrysene | 10 | 0.33 |
| Di-n-butylphthalate | 10 | 0.33 |
| Di-n-octylphthalate | 10 | 0.33 |
| Dibenz(a,h)anthracene | 10 | 0.33 |
| Dibenzofuran | 10 | 0.33 |
| Diethylphthalate | 10 | 0.33 |
| Dimethylphthalate | 10 | 0.33 |
| Fluoranthene | 10 | 0.33 |
| Fluorene | 10 | 0.33 |
| Hexachlorobenzene | 10 | 0.33 |
| Hexachlorobutadiene | 10 | 0.33 |
| Hexachlorocyclopentadiene | 10 | 0.33 |
| Hexachloroethane | 10 | 0.33 |
| Indeno(1,2,3-cd)pyrene | 10 | 0.33 |
| Isophorone | 10 | 0.33 |
| N-Nitroso-di-n-propylamine | 10 | 0.33 |
| N-nitrosodiphenylamine | 10 | 0.33 |
| Naphthalene | 10 | 0.33 |
| Nitrobenzene | 10 | 0.33 |
| Pentachlorophenol | 25 | 0.8 |
| Phenanthrene | 10 | 0.33 |
| Phenol | 10 | 0.33 |
| Pyrene | 10 | 0.33 |

Notes:

Mg/L = micrograms per liter.

mg/kg = milligrams per kilogram.

NA = Not available.

PRG = U.S. EPA Preliminary Remediation Goals, Region 9 May 1, 1998.

Table 2. Summary of Calibration Procedures for SVOCs by SW-846 Method 8270C

| Calibration Element | Frequency | Acceptance Criteria | Corrective Action |
|---|---|---|---|
| GC/MS Tuning with decafluorotriphenyl-phosphine (DFTPP) | Beginning of each 12- hour period during which standards samples are analyzed | Ion abundance criteria in Table 3 of Method 8270C, Revision 3.0 | 1. Identify the problem. 2. MS tune criteria must be met before any calibration standards, samples, blanks, or QC samples are analyzed |
| Initial Calibration (minimum blank + 5 points for each analyte) (ICAL) ^{a, b, c} | Initially; whenever required, due to failure of CCV | RSD for RRFs $\leq 30\%$; or correlation coefficient (r) generated by the linear regression must be ≥ 0.99 for all analytes | 1. Terminate analysis 2. Recalibrate and verify before sample analysis |
| Continuing Calibration Verification (CCV) ^d | Beginning of every 12-hour period, and end of run | %D between RRF of CCV and avg RRFs from ICAL $\leq 30\%$; or $\pm 30\%$ of true value for linear regression | 1. Re-calibrate and verify 2. Re-analyze samples back to last good CCV |
| Integrated areas of Internal Standards | Each analysis | Area must be within -50 to 100 percent. | 1. Re-analyze samples with internal standard -50 percent and greater than 100 percent |
| Retention time evaluation of all standard, surrogate, and sample analytes | Each analysis | $\pm 3 \times$ the SD of the avg ICAL RT for each analyte | 1. Re-calibrate and verify 2. Re-analyze samples out control limits |

^a The ICAL low standard must be above but near the CRQL. The low ICAL standard must have a signal to noise ratio $\geq 5:1$. If this requirement cannot be met, the laboratory must submit a MDL study as part of the data package.

^b ICAL and continuing CAL standards must contain all target analytes listed in Table 1B.

^c Report the retention time window for each analyte. Determine retention time windows as $\pm 3 \times$ the standard deviation of the average initial calibration retention time for each analyte.

^d If some compounds are beyond the control limits of the CCV and these target compounds are detected in samples and 10 percent or less of these analytes are beyond control limits, a single point calibration may be used to quantify the out-of-control analytes.

Table 3. Summary of Internal Quality Control Procedures for SVOCs by SW-846 Method 8270C

| QC Element | Frequency | Acceptance Criteria ^b | Corrective Action |
|--|---|---|--|
| Method Blank (MB) | Each 12-hour time period, minimum of one per SDG ^a | < CRQL for each compound | 1. Investigate the source of contamination and document. 2. Re-analyze all samples processed with a blank that is out of control. |
| Matrix Spike and Matrix Spike Duplicate (MS/MSD) | One MS/MSD set per batch or SDG (1 MS/MSD set per 20 samples minimum) | <u>Water Sample</u> : MS and MSD recoveries and RPD between within laboratory limits <u>Soil Sample</u> : MS and MSD recoveries and RPD between within laboratory limits | 1. Report in case narrative |
| Surrogate Spikes | Every sample, standard and method blank | <u>Water Sample</u> : Surrogate recoveries within laboratory limits <u>Soil Sample</u> : Surrogate recoveries within laboratory limits | 1. Re-analyze all samples with non-compliant surrogate recoveries |
| Laboratory Control Sample (LCS) | One per SDG | <u>Water Sample</u> : LCS recoveries within laboratory limits <u>Soil Sample</u> : LCS recoveries within laboratory limits | 1. Investigate the source of problem and document. 2. Re-analyze all samples processed with a LCS that is out of control. |

^a SDG - Sample Delivery Group - each case of field samples received; or each 20 field samples within a case; or each 14 calendar day period during which field samples in a case are received.

^b within 3 sigma of laboratory control charts. The laboratory should submit the control charts.

Dilute and reanalyze samples which contain one or more target analytes at concentrations above the initial calibration range. Results for such reanalyses should fall within the mid-range of the calibration curve. Report results and submit documentation for both analyses.



Optical Microscopy Laboratory Services

Forensic Analytical's optical microscopy laboratories have become nationally recognized as one of the leaders in providing quality on a consistent basis. The company maintains accredited laboratories in the San Francisco Bay Area, the Los Angeles Area, and Portland. These laboratories are staffed with skilled scientists extensively trained in the area of microscopic crystalline material identification and quantification, especially asbestos. The laboratories are also equipped with a state-of-the art laboratory information management system (LIMS) that allows for a high number of samples to be logged in, tracked, analyzed, pass through quality control, and reported.

Phase Contrast Microscopy Analysis (PCM)

Forensic Analytical's phase contrast microscopy laboratories operate with a special emphasis on quality data. Though the laboratories are extremely efficient, and designed for high-throughput, each sample is handled with a great deal of care.

The laboratory performs standard methods for fiber counting (NIOSH 7400A and B counting rules). The laboratory makes use of Forensic Analytical's customized laboratory information management system, which helps perform calculations, quality control and final reporting. This system speeds up analysis, and lowers costs for clients. The standard turnaround time for PCM analysis is 24 hours, with same day or RUSH turnaround times available.

The laboratories are active participants in the American Industrial Hygiene Association's (AIHA) Proficiency Analytical Testing (PAT) program and are accredited by the American Industrial Hygiene Association.

Polarized Light Microscopy Analysis (PLM)

Forensic Analytical's polarized light microscopy laboratories provide high quality analysis of building materials, dust samples, and soil samples. The laboratories provide standard methods such as the EPA 600/R-93-116 for asbestos analysis in building materials. The laboratories are also capable of providing specialty analyses, such as the California Air Resources Board ARB 435 Method for analysis of asbestos in serpentine rock.

Special consideration is given to quality control in the PLM laboratories. As part of the laboratories' quality control program, 100% of all client submitted samples containing less than 1% asbestos are reviewed. The laboratories are also an active participant in the Proficiency Analytical Testing program, accredited by the National Voluntary Laboratory Accreditation Program (NVLAP), and are certified by several state managed certifying organizations, including the California Department of Health Services (DHS).

Particulate Identification

An effective strategy for determining indoor air quality problem sources is the combination approach of using light and electron microscopy identifications of dust components.

Most indoor dusts are composed of relatively common environmental materials including organic and mineral fibers, mineral grains, metal oxides, and biological particulate. These dusts typically have mixed sources including particulate derived from building materials, textiles, paper dusts, soils, and biological sources. The complete characterization of indoor dusts usually involves a two level analysis. Most materials are easily identified by polarized light microscopy, and often this alone is sufficient. Occasionally, additional analysis by scanning electron microscopy (SEM) or micro-fourier transform infrared spectroscopy (FTIR) is warranted, both of which Forensic Analytical can perform.



Optical Microscopy Techniques and Procedures

Bulk Material Analysis

Method: Bulk samples are examined by Polarized Light Microscopy (PLM) with Dispersion Staining as recommended by the US Environmental Protection Agency (EPA).

Description: Gross characteristics are observed and described under low magnification. Each sample component is then mounted on a microscope slide with refractive index oils. The slides are examined for presence, type, and concentration of asbestos minerals.

Results: Results are reported as a percent (%) range of total asbestos present. Sample concentrations are also reported as % asbestos by type. Other non-asbestos materials may also be identified.

Explanation: Reported results are a visual estimate by area of asbestos concentration. Results for heterogeneous samples examined by component are reported as a composite. The lower limit of reliable detection for this method is 1%. Samples which contain more than 1% asbestos are reported in % ranges. Samples which contain asbestos in a concentration lower than the limit of reliable detection (<1%) are reported as "Trace." Samples in which no asbestos is observed are reported as "None-Detected." NOTE: When "None Detected" appears on a report, it means that asbestos was not observed and that, if present, it exists in concentrations less than the limit of reliable detection (<1%) and/or fiber dimensions too small for accurate microscopic resolution.

Interpretation: Reported results for similar samples may vary due to lack of sample homogeneity, differing collection methods and/or analyst variability. Samples reported as "None Detected" may require a more definitive method of analysis to confirm the absence of any asbestos. Regulations relating to asbestos may be obtained from federal and state agencies.

Airborne Fiber Analysis

Method: Airborne asbestos sample cassettes submitted for total fiber count are examined by Phase Contrast Microscopy (PCM) following the NIOSH Method 7400, counting rules "A."

Description: The cassette is opened and a section of the filter is removed and mounted on a slide. The filter material is dissolved away, leaving fibers and particulates visible. The slide is then examined and the number of fibers in a specific microscopic field are counted.

Results: Results are calculated from values obtained from sample collection volume and the number of fibers and microscopic fields counted. Results are reported as calculated fibers per cubic centimeter (f/cc) and include all fibers observed, both asbestos and non-asbestos.

Explanation: Because of the nature of these tests and assumptions made by the method, additional information is included in our reports to facilitate interpretation of results. The Limit Of Detection (LOD) for the method is a calculated number representing the result below which the reliability of the method comes into question. For this reason, results with a calculated f/cc level below the LOD should be evaluated at the LOD. The 95% Upper Confidence Limit (UCL) is a statistical calculation of the laboratory's ability to repeat analytical results. The number represents an uppermost calculated value for each sample. The "true" value will fall below this number 95% of the time. The UCL is calculated from data developed in our laboratory in accordance with the NIOSH Method 7400 protocol.

Interpretation: Permissible exposure levels and standards may be obtained from federal and state agencies.

APPENDIX D

VISUAL SAMPLING PLAN WORKSHEETS

Systematic sampling locations for detecting an area of elevated values (hot spot)

This report summarizes the sampling design used, associated statistical assumptions, as well as general guidelines for conducting post-sampling data analysis. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design developed. A figure that shows sampling locations in the field and a table that lists sampling location coordinates are also provided below.

| SUMMARY OF SAMPLING DESIGN | |
|--|---|
| Primary Objective of Design | Detect the presence of a hot spot that has a specified size and shape |
| Type of Sampling Design | Hot spot |
| Sample Placement (Location) in the Field | Systematic (Hot Spot) with a random start location |
| Formula for calculating number of sampling locations | Singer and Wickman algorithm |
| Calculated total number of samples | 44 |
| Number of samples on map ^a | 28 |
| Number of selected sample areas ^b | 1 |
| Specified sampling area ^c | 4508.30 m ² |
| Grid pattern | Square |
| Size of grid / Area of grid cell ^d | 40 feet / 1600 ft ² |
| Total cost of sampling ^e | \$23000.00 |

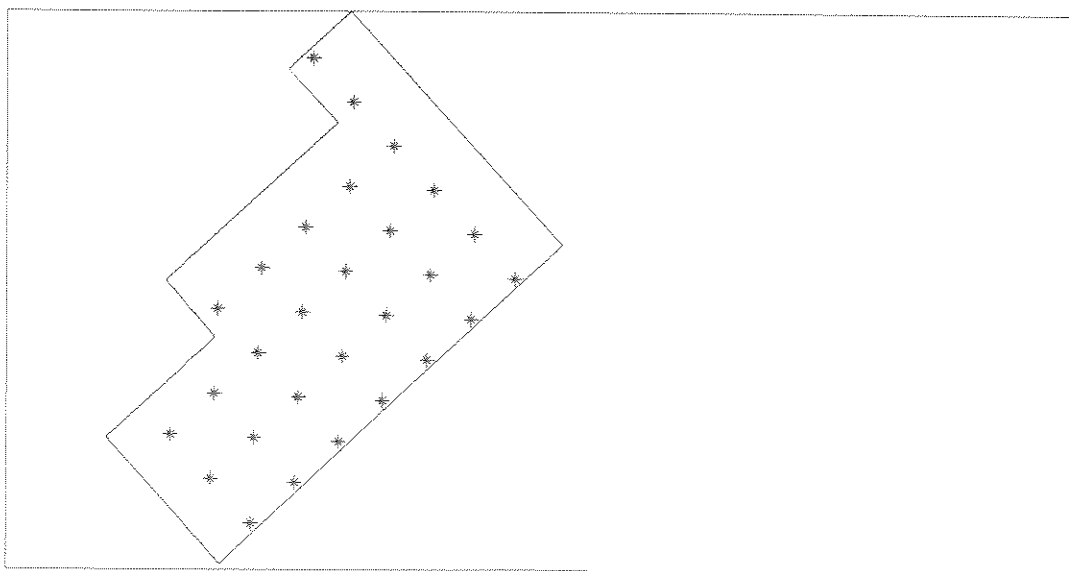
^a This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.

^b The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.

^c The sampling area is the total surface area of the selected colored sample areas on the map of the site.

^d Size of grid / Area of grid cell gives the linear and square dimensions of the grid used to systematically place samples.

^e Including measurement analyses and fixed overhead costs. See the Cost of Sampling section for an explanation of the costs presented here.



| Area: Area 3 | | | | | |
|--------------|--------------|-------|-------|---------|------------|
| X Coord | Y Coord | Label | Value | Type | Historical |
| 572621.0479 | 4176443.0549 | | 0 | Hotspot | |
| 572629.3175 | 4176434.0961 | | 0 | Hotspot | |
| 572637.5871 | 4176425.1374 | | 0 | Hotspot | |
| 572628.6284 | 4176416.8678 | | 0 | Hotspot | |
| 572619.6696 | 4176408.5982 | | 0 | Hotspot | |
| 572610.7109 | 4176400.3285 | | 0 | Hotspot | |
| 572601.7521 | 4176392.0589 | | 0 | Hotspot | |
| 572645.8568 | 4176416.1786 | | 0 | Hotspot | |
| 572636.8980 | 4176407.9090 | | 0 | Hotspot | |
| 572627.9393 | 4176399.6394 | | 0 | Hotspot | |
| 572618.9805 | 4176391.3698 | | 0 | Hotspot | |
| 572610.0218 | 4176383.1002 | | 0 | Hotspot | |
| 572601.0630 | 4176374.8306 | | 0 | Hotspot | |
| 572592.1043 | 4176366.5609 | | 0 | Hotspot | |
| 572654.1264 | 4176407.2199 | | 0 | Hotspot | |
| 572645.1676 | 4176398.9503 | | 0 | Hotspot | |
| 572636.2089 | 4176390.6807 | | 0 | Hotspot | |
| 572627.2501 | 4176382.4110 | | 0 | Hotspot | |
| 572618.2914 | 4176374.1414 | | 0 | Hotspot | |
| 572609.3326 | 4176365.8718 | | 0 | Hotspot | |
| 572600.3739 | 4176357.6022 | | 0 | Hotspot | |
| 572662.3960 | 4176398.2611 | | 0 | Hotspot | |
| 572653.4372 | 4176389.9915 | | 0 | Hotspot | |
| 572644.4785 | 4176381.7219 | | 0 | Hotspot | |
| 572635.5197 | 4176373.4523 | | 0 | Hotspot | |
| 572626.5610 | 4176365.1827 | | 0 | Hotspot | |
| 572617.6022 | 4176356.9131 | | 0 | Hotspot | |
| 572608.6435 | 4176348.6434 | | 0 | Hotspot | |

Primary Sampling Objective

The primary purpose of sampling at this site is to detect "hot spots" (local areas of elevated concentration) of a given size and shape with a specified probability, $1-\beta$.

Selected Sampling Approach

This sampling approach requires systematic grid sampling with a random start. If a systematic grid is not used, the probability of detecting a hot spot of a given size and shape will be different than desired or calculated.

Number of Total Samples: Calculation Equation and Inputs

The algorithm used to calculate the grid size (and hence, the number of samples) is based on work by Singer for locating geologic deposits [see Singer (1972, 1975) and PNNL-13450 for details]. Inputs to the algorithm include the size, shape, and orientation of a hot spot of interest, an acceptable probability of not finding a hot spot, the desired type of sampling grid, and the sampling budget. For this design, the grid size was calculated based on a given hot spot size and other parameters.

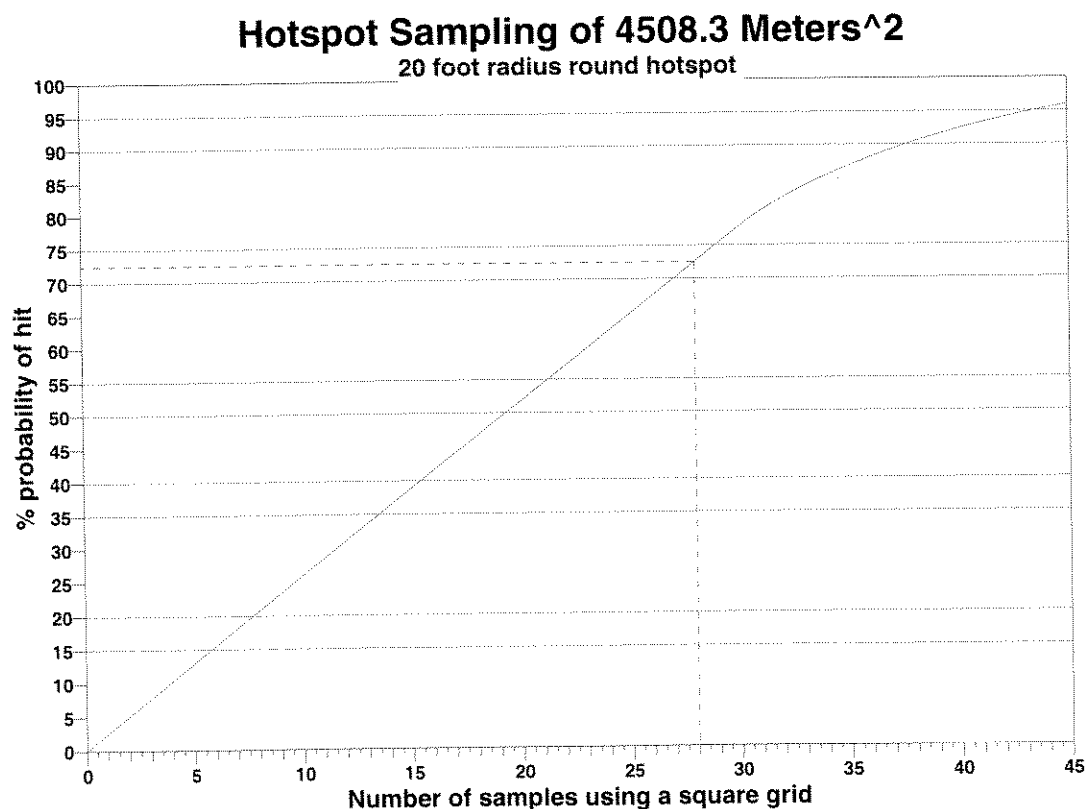
The inputs to the algorithm that result in the grid size are:

| Parameter | Description | Value |
|----------------------------|---|-------------------------|
| Inputs | | |
| 1- β | Probability of detection | 95% |
| Grid Type | Grid pattern (Square, Triangular or Rectangular) | Square |
| Hot Spot Shape | Hot spot height to width ratio | 1 |
| Hot Spot Size | Length of hot spot semi-major axis | 20 feet |
| Hot Spot Area ^a | Area of hot spot ($\text{Length}^2 * \text{Shape} * \pi$) | 1256.64 ft ² |
| Angle | Angle of orientation between hot spot and grid | Random |
| Sampling Area | Total area to sample | 4508.30 m ² |
| Outputs | | |
| Grid Size | Length of side of grid | 40 feet |
| Grid Area | Area covered by one grid cell | 1600 ft ² |
| Samples ^b | Optimum number of samples | 43.5372 |

^a Length of semi-major axis is used by algorithm. Hot spot area is provided for informational purposes.

^b The optimum number of samples is calculated by dividing the sampling area by the grid area.

The following graph shows the relationship between number of samples and the probability of finding the hot spot. The dashed blue line shows the actual number of samples for this design (which may differ from the optimum number of samples because of edge effects).



Statistical Assumptions

The assumptions associated with the sample spacing algorithm are that:

1. the target hot spot (its projection onto the coordinate plane) is circular or elliptical,
2. samples are taken on a square, rectangular, or triangular grid,
3. a very small proportion of the area being studied will be sampled (the sample is much smaller than the hot spot of interest),
4. the level of contamination that classifies a hot spot is well defined, and
5. there are no misclassification errors (a hot spot is not mistakenly overlooked or an area is not mistakenly identified as a hot spot).

These assumptions cannot be validated through data collection. The size and shape of a hot spot of interest are well defined prior to determining the number of samples and the measured value that defines a hot spot is well above the detection limit for the analytical methods that will be used. Grid sampling will be carried out to the level achievable; topographic, vegetative, and other features that prevent sampling at the specified coordinates will be noted and their influence recognized.

Sensitivity Analysis

The sensitivity of the calculation of number of samples was explored by varying Area and Side and examining the resulting changes in the number of samples. The following table shows the results of this analysis.

| Number of Samples | | | |
|-------------------|---------|---------|---------|
| | Side=20 | Side=40 | Side=60 |
| Area=2254.15 | 22 | 22 | 22 |
| Area=4508.3 | 44 | 44 | 44 |
| Area=6762.44 | 66 | 66 | 66 |

Area = Total Sampling Area

Side = Length of Grid Side

Cost of Sampling

The total cost of the completed sampling program depends on several cost inputs, some of which are fixed, and others that are based on the number of samples collected and measured. Based on the numbers of samples determined above, the estimated total cost of sampling and analysis at this site is ~~\$23000.00~~, which averages out to a per sample cost of ~~\$522.79~~. The following table summarizes the inputs and resulting cost estimates.

| COST INFORMATION | | | |
|--|--------------|-----------------|-------------------|
| Cost Details | Per Analysis | Per Sample | 44 Samples |
| Field collection costs | | \$100.00 | \$4400.00 |
| Analytical costs | \$400.00 | \$400.00 | \$17600.00 |
| Sum of Field & Analytical costs | | \$500.00 | \$22000.00 |
| Fixed planning and validation costs | | | \$1000.00 |
| Total cost | | | \$23000.00 |

Recommended Data Analysis Activities

Post data collection activities generally follow those outlined in EPA's Guidance for Data Quality Assessment (EPA, 2000). The data analysts will become familiar with the context of the problem and goals for data collection and assessment. The data will be verified and validated before being subjected to statistical or other analyses. Graphical and analytical tools will be used to verify to the extent possible the assumptions of any statistical analyses that are performed as well as to achieve a general understanding of the data. The data will be assessed to determine whether they are adequate in both quality and quantity to support the primary objective of sampling.

A map of the actual sample locations will be generated so that the sampling plan and the field implementation may be compared. Deviations from planned sample locations due to topographic, vegetative, or other features will be noted. Their impacts will be qualitatively assessed. If a hot spot is discovered, additional sampling may be performed to determine its size and shape, in which case, the initial assumptions of the sampling design may then be assessed and/or reconsidered.

Systematic sampling locations for detecting an area of elevated values (hot spot)

This report summarizes the sampling design used, associated statistical assumptions, as well as general guidelines for conducting post-sampling data analysis. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design developed. A figure that shows sampling locations in the field and a table that lists sampling location coordinates are also provided below.

| SUMMARY OF SAMPLING DESIGN | |
|--|---|
| Primary Objective of Design | Detect the presence of a hot spot that has a specified size and shape |
| Type of Sampling Design | Hot spot |
| Sample Placement (Location) in the Field | Systematic (Hot Spot) with a random start location |
| Formula for calculating number of sampling locations | Singer and Wickman algorithm |
| Calculated total number of samples | 13 |
| Number of samples on map ^a | 8 |
| Number of selected sample areas ^b | 1 |
| Specified sampling area ^c | 397.00 m ² |
| Grid pattern | Square |
| Size of grid / Area of grid cell ^d | 20 feet / 400 ft ² |
| Total cost of sampling ^e | \$7500.00 |

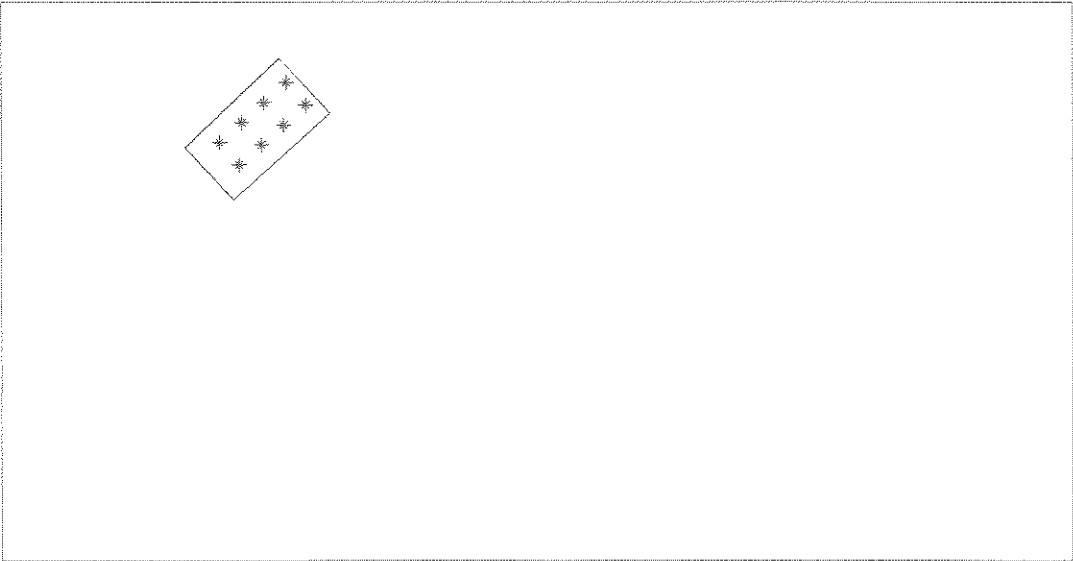
^a This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.

^b The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.

^c The sampling area is the total surface area of the selected colored sample areas on the map of the site.

^d Size of grid / Area of grid cell gives the linear and square dimensions of the grid used to systematically place samples.

^e Including measurement analyses and fixed overhead costs. See the Cost of Sampling section for an explanation of the costs presented here.



| Area: Area 2 | | | | | |
|--------------|--------------|-------|-------|---------|------------|
| X Coord | Y Coord | Label | Value | Type | Historical |
| 572616.8381 | 4176436.1893 | | 0 | Hotspot | |
| 572612.2923 | 4176432.1276 | | 0 | Hotspot | |
| 572607.7464 | 4176428.0660 | | 0 | Hotspot | |
| 572603.2006 | 4176424.0043 | | 0 | Hotspot | |
| 572620.8997 | 4176431.6435 | | 0 | Hotspot | |
| 572616.3539 | 4176427.5818 | | 0 | Hotspot | |
| 572611.8081 | 4176423.5202 | | 0 | Hotspot | |
| 572607.2623 | 4176419.4585 | | 0 | Hotspot | |

Primary Sampling Objective

The primary purpose of sampling at this site is to detect "hot spots" (local areas of elevated concentration) of a given size and shape with a specified probability, $1-\beta$.

Selected Sampling Approach

This sampling approach requires systematic grid sampling with a random start. If a systematic grid is not used, the probability of detecting a hot spot of a given size and shape will be different than desired or calculated.

Number of Total Samples: Calculation Equation and Inputs

The algorithm used to calculate the grid size (and hence, the number of samples) is based on work by Singer for locating geologic deposits [see Singer (1972, 1975) and PNNL-13450 for details]. Inputs to the algorithm include the size, shape, and orientation of a hot spot of interest, an acceptable probability of not finding a hot spot, the desired type of sampling grid, and the sampling budget. For this design, the grid size was calculated based on a given hot spot size and other parameters.

The inputs to the algorithm that result in the grid size are:

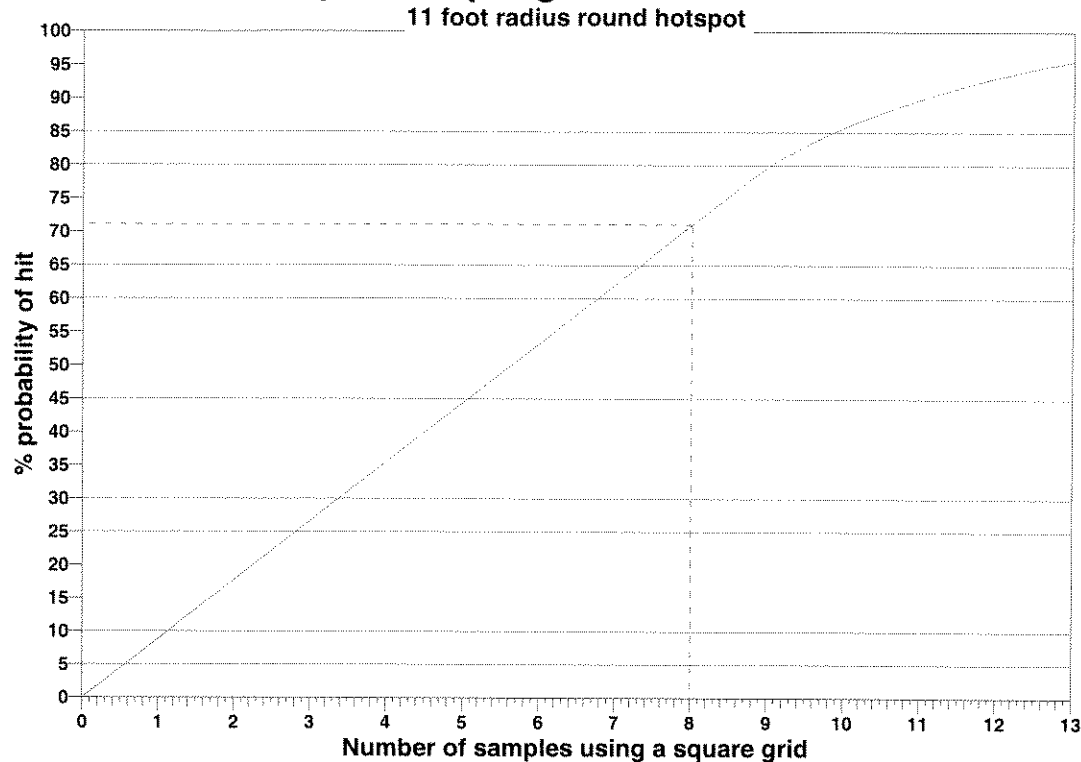
| Parameter | Description | Value |
|----------------------------|---|-------------------------|
| Inputs | | |
| $1-\beta$ | Probability of detection | 95% |
| Grid Type | Grid pattern (Square, Triangular or Rectangular) | Square |
| Hot Spot Shape | Hot spot height to width ratio | 1 |
| Hot Spot Size | Length of hot spot semi-major axis | 11 feet |
| Hot Spot Area ^a | Area of hot spot ($\text{Length}^2 \times \text{Shape} \times \pi$) | 380.133 ft ² |
| Angle | Angle of orientation between hot spot and grid | Random |
| Sampling Area | Total area to sample | 397.00 m ² |
| Outputs | | |
| Grid Size | Length of side of grid | 20 feet |
| Grid Area | Area covered by one grid cell | 400 ft ² |
| Samples ^b | Optimum number of samples | 12.6739 |

^a Length of semi-major axis is used by algorithm. Hot spot area is provided for informational purposes.

^b The optimum number of samples is calculated by dividing the sampling area by the grid area.

The following graph shows the relationship between number of samples and the probability of finding the hot spot. The dashed blue line shows the actual number of samples for this design (which may differ from the optimum number of samples because of edge effects).

Hotspot Sampling of 396.999 Meters²



Statistical Assumptions

The assumptions associated with the sample spacing algorithm are that:

1. the target hot spot (its projection onto the coordinate plane) is circular or elliptical,
2. samples are taken on a square, rectangular, or triangular grid,
3. a very small proportion of the area being studied will be sampled (the sample is much smaller than the hot spot of interest),
4. the level of contamination that classifies a hot spot is well defined, and
5. there are no misclassification errors (a hot spot is not mistakenly overlooked or an area is not mistakenly identified as a hot spot).

These assumptions cannot be validated through data collection. The size and shape of a hot spot of interest are well defined prior to determining the number of samples and the measured value that defines a hot spot is well above the detection limit for the analytical methods that will be used. Grid sampling will be carried out to the level achievable; topographic, vegetative, and other features that prevent sampling at the specified coordinates will be noted and their influence recognized.

Sensitivity Analysis

The sensitivity of the calculation of number of samples was explored by varying Area and Side and examining the resulting changes in the number of samples. The following table shows the results of this analysis.

| Number of Samples | | | |
|-------------------|---------|---------|---------|
| | Side=10 | Side=20 | Side=30 |
| Area=198.499 | 7 | 7 | 7 |
| Area=396.999 | 13 | 13 | 13 |
| Area=595.498 | 20 | 20 | 20 |

Area = Total Sampling Area

Side = Length of Grid Side

Cost of Sampling

The total cost of the completed sampling program depends on several cost inputs, some of which are fixed, and others

that are based on the number of samples collected and measured. Based on the numbers of samples determined above, the estimated total cost of sampling and analysis at this site is ~~\$7500.00~~, which averages out to a per sample cost of ~~\$576.92~~. The following table summarizes the inputs and resulting cost estimates.

| COST INFORMATION | | | |
|--|---------------------|---------------------|----------------------|
| Cost Details | Per Analysis | Per Sample | 13 Samples |
| Field collection costs | | \$100.00 | \$1300.00 |
| Analytical costs | \$400.00 | \$400.00 | \$5200.00 |
| Sum of Field & Analytical costs | | \$500.00 | \$6500.00 |
| Fixed planning and validation costs | | | \$1000.00 |
| Total cost | | | \$7500.00 |

Recommended Data Analysis Activities

Post data collection activities generally follow those outlined in EPA's Guidance for Data Quality Assessment (EPA, 2000). The data analysts will become familiar with the context of the problem and goals for data collection and assessment. The data will be verified and validated before being subjected to statistical or other analyses. Graphical and analytical tools will be used to verify to the extent possible the assumptions of any statistical analyses that are performed as well as to achieve a general understanding of the data. The data will be assessed to determine whether they are adequate in both quality and quantity to support the primary objective of sampling.

A map of the actual sample locations will be generated so that the sampling plan and the field implementation may be compared. Deviations from planned sample locations due to topographic, vegetative, or other features will be noted. Their impacts will be qualitatively assessed. If a hot spot is discovered, additional sampling may be performed to determine its size and shape, in which case, the initial assumptions of the sampling design may then be assessed and/or reconsidered.

This report was automatically produced* by Visual Sample Plan (VSP) software version 4.0a.

Software and documentation available at <http://dco.pnl.gov/vsp>

Software copyright (c) 2005 Battelle Memorial Institute. All rights reserved.

* - The report contents may have been modified or reformatted by end-user of software.

Systematic sampling locations for detecting an area of elevated values (hot spot)

This report summarizes the sampling design used, associated statistical assumptions, as well as general guidelines for conducting post-sampling data analysis. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design developed. A figure that shows sampling locations in the field and a table that lists sampling location coordinates are also provided below.

| SUMMARY OF SAMPLING DESIGN | |
|--|---|
| Primary Objective of Design | Detect the presence of a hot spot that has a specified size and shape |
| Type of Sampling Design | Hot spot |
| Sample Placement (Location) in the Field | Systematic (Hot Spot) with a random start location |
| Formula for calculating number of sampling locations | Singer and Wickman algorithm |
| Calculated total number of samples | 10 |
| Number of samples on map ^a | 8 |
| Number of selected sample areas ^b | 1 |
| Specified sampling area ^c | 306.95 m ² |
| Grid pattern | Square |
| Size of grid / Area of grid cell ^d | 20 feet / 400 ft ² |
| Total cost of sampling ^e | \$6000.00 |

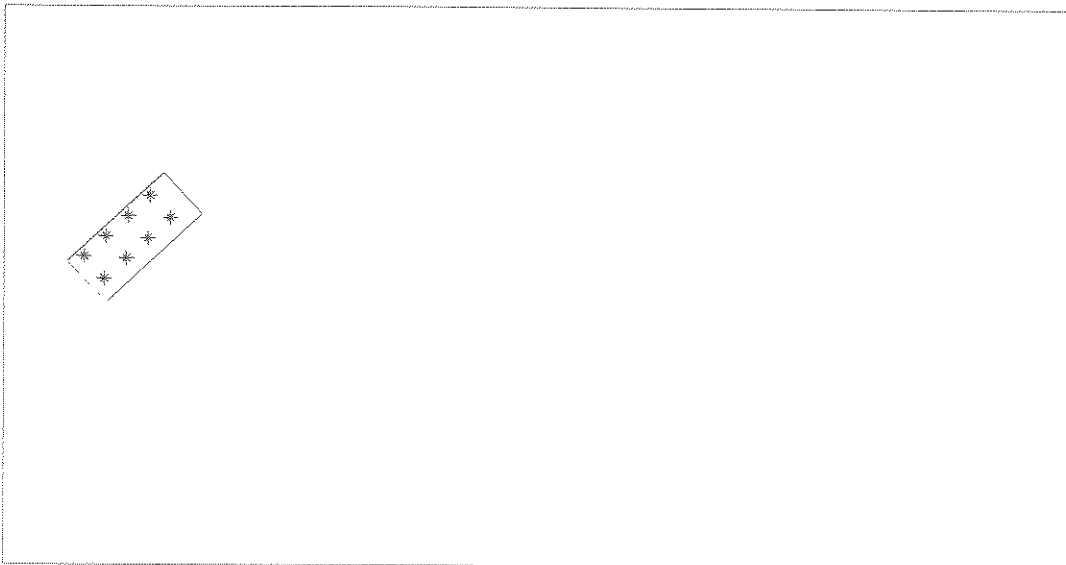
^a This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.

^b The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.

^c The sampling area is the total surface area of the selected colored sample areas on the map of the site.

^d Size of grid / Area of grid cell gives the linear and square dimensions of the grid used to systematically place samples.

^e Including measurement analyses and fixed overhead costs. See the Cost of Sampling section for an explanation of the costs presented here.



| Area: Area 1 | | | | | |
|--------------|--------------|-------|-------|---------|------------|
| X Coord | Y Coord | Label | Value | Type | Historical |
| 572588.4450 | 4176413.9434 | | 0 | Hotspot | |
| 572583.9441 | 4176409.8320 | | 0 | Hotspot | |
| 572579.4432 | 4176405.7206 | | 0 | Hotspot | |
| 572574.9423 | 4176401.6092 | | 0 | Hotspot | |
| 572592.5563 | 4176409.4425 | | 0 | Hotspot | |
| 572588.0555 | 4176405.3311 | | 0 | Hotspot | |
| 572583.5546 | 4176401.2197 | | 0 | Hotspot | |
| 572579.0537 | 4176397.1084 | | 0 | Hotspot | |

Primary Sampling Objective

The primary purpose of sampling at this site is to detect "hot spots" (local areas of elevated concentration) of a given size and shape with a specified probability, $1-\beta$.

Selected Sampling Approach

This sampling approach requires systematic grid sampling with a random start. If a systematic grid is not used, the probability of detecting a hot spot of a given size and shape will be different than desired or calculated.

Number of Total Samples: Calculation Equation and Inputs

The algorithm used to calculate the grid size (and hence, the number of samples) is based on work by Singer for locating geologic deposits [see Singer (1972, 1975) and PNNL-13450 for details]. Inputs to the algorithm include the size, shape, and orientation of a hot spot of interest, an acceptable probability of not finding a hot spot, the desired type of sampling grid, and the sampling budget. For this design, the grid size was calculated based on a given hot spot size and other parameters.

The inputs to the algorithm that result in the grid size are:

| Parameter | Description | Value |
|----------------------------|---|-------------------------|
| Inputs | | |
| $1-\beta$ | Probability of detection | 95% |
| Grid Type | Grid pattern (Square, Triangular or Rectangular) | Square |
| Hot Spot Shape | Hot spot height to width ratio | 1 |
| Hot Spot Size | Length of hot spot semi-major axis | 11 feet |
| Hot Spot Area ^a | Area of hot spot ($\text{Length}^2 * \text{Shape} * \pi$) | 380.133 ft ² |
| Angle | Angle of orientation between hot spot and grid | Random |
| Sampling Area | Total area to sample | 306.95 m ² |
| Outputs | | |
| Grid Size | Length of side of grid | 20 feet |
| Grid Area | Area covered by one grid cell | 400 ft ² |
| Samples ^b | Optimum number of samples | 9.79904 |

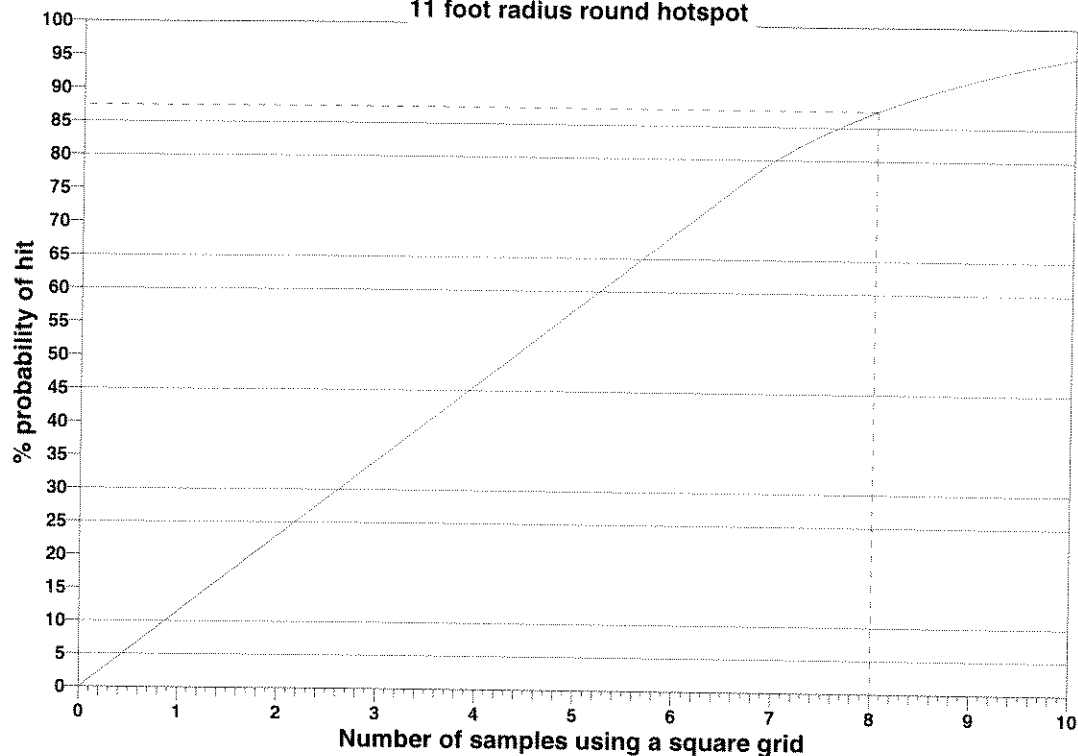
^a Length of semi-major axis is used by algorithm. Hot spot area is provided for informational purposes.

^b The optimum number of samples is calculated by dividing the sampling area by the grid area.

The following graph shows the relationship between number of samples and the probability of finding the hot spot. The dashed blue line shows the actual number of samples for this design (which may differ from the optimum number of samples because of edge effects).

Hotspot Sampling of 306.945 Meters²

11 foot radius round hotspot



Statistical Assumptions

The assumptions associated with the sample spacing algorithm are that:

1. the target hot spot (its projection onto the coordinate plane) is circular or elliptical,
2. samples are taken on a square, rectangular, or triangular grid,
3. a very small proportion of the area being studied will be sampled (the sample is much smaller than the hot spot of interest),
4. the level of contamination that classifies a hot spot is well defined, and
5. there are no misclassification errors (a hot spot is not mistakenly overlooked or an area is not mistakenly identified as a hot spot).

These assumptions cannot be validated through data collection. The size and shape of a hot spot of interest are well defined prior to determining the number of samples and the measured value that defines a hot spot is well above the detection limit for the analytical methods that will be used. Grid sampling will be carried out to the level achievable; topographic, vegetative, and other features that prevent sampling at the specified coordinates will be noted and their influence recognized.

Sensitivity Analysis

The sensitivity of the calculation of number of samples was explored by varying Area and Side and examining the resulting changes in the number of samples. The following table shows the results of this analysis.

| Number of Samples | | | |
|-------------------|---------|---------|---------|
| | Side=10 | Side=20 | Side=30 |
| Area=153.473 | 5 | 5 | 5 |
| Area=306.945 | 10 | 10 | 10 |
| Area=460.418 | 15 | 15 | 15 |

Area = Total Sampling Area

Side = Length of Grid Side

Cost of Sampling

The total cost of the completed sampling program depends on several cost inputs, some of which are fixed, and others

that are based on the number of samples collected and measured. Based on the numbers of samples determined above, the estimated total cost of sampling and analysis at this site is ~~\$6000.00~~, which averages out to a per sample cost of ~~\$600.00~~. The following table summarizes the inputs and resulting cost estimates.

| COST INFORMATION | | | |
|--|---------------------|---------------------|----------------------|
| Cost Details | Per Analysis | Per Sample | 10 Samples |
| Field collection costs | | \$100.00 | \$1000.00 |
| Analytical costs | \$400.00 | \$400.00 | \$4000.00 |
| Sum of Field & Analytical costs | | \$500.00 | \$5000.00 |
| Fixed planning and validation costs | | | \$1000.00 |
| Total cost | | | \$6000.00 |

Recommended Data Analysis Activities

Post data collection activities generally follow those outlined in EPA's Guidance for Data Quality Assessment (EPA, 2000). The data analysts will become familiar with the context of the problem and goals for data collection and assessment. The data will be verified and validated before being subjected to statistical or other analyses. Graphical and analytical tools will be used to verify to the extent possible the assumptions of any statistical analyses that are performed as well as to achieve a general understanding of the data. The data will be assessed to determine whether they are adequate in both quality and quantity to support the primary objective of sampling.

A map of the actual sample locations will be generated so that the sampling plan and the field implementation may be compared. Deviations from planned sample locations due to topographic, vegetative, or other features will be noted. Their impacts will be qualitatively assessed. If a hot spot is discovered, additional sampling may be performed to determine its size and shape, in which case, the initial assumptions of the sampling design may then be assessed and/or reconsidered.

This report was automatically produced* by Visual Sample Plan (VSP) software version 4.0a.

Software and documentation available at <http://dco.pnl.gov/vsp>

Software copyright (c) 2005 Battelle Memorial Institute. All rights reserved.

* - The report contents may have been modified or reformatted by end-user of software.

Systematic sampling locations for detecting an area of elevated values (hot spot)

This report summarizes the sampling design used, associated statistical assumptions, as well as general guidelines for conducting post-sampling data analysis. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design developed. A figure that shows sampling locations in the field and a table that lists sampling location coordinates are also provided below.

| SUMMARY OF SAMPLING DESIGN | |
|--|---|
| Primary Objective of Design | Detect the presence of a hot spot that has a specified size and shape |
| Type of Sampling Design | Hot spot |
| Sample Placement (Location) in the Field | Systematic (Hot Spot) with a random start location |
| Formula for calculating number of sampling locations | Singer and Wickman algorithm |
| Calculated total number of samples | 7 |
| Number of samples on map ^a | 6 |
| Number of selected sample areas ^b | 1 |
| Specified sampling area ^c | 208.64 m ² |
| Grid pattern | Square |
| Size of grid / Area of grid cell ^d | 20 feet / 400 ft ² |
| Total cost of sampling ^e | \$4500.00 |

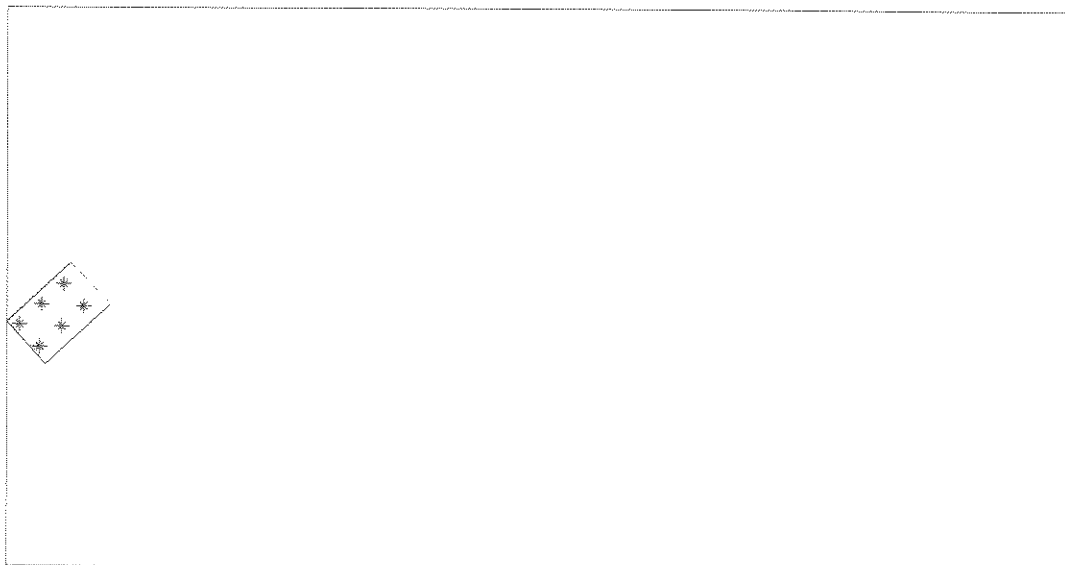
^a This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.

^b The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.

^c The sampling area is the total surface area of the selected colored sample areas on the map of the site.

^d Size of grid / Area of grid cell gives the linear and square dimensions of the grid used to systematically place samples.

^e Including measurement analyses and fixed overhead costs. See the Cost of Sampling section for an explanation of the costs presented here.



| Area: Area 4 | | | | | |
|--------------|--------------|-------|-------|---------|------------|
| X Coord | Y Coord | Label | Value | Type | Historical |
| 572570.2447 | 4176396.3092 | | 0 | Hotspot | |
| 572565.7257 | 4176392.2177 | | 0 | Hotspot | |
| 572561.2068 | 4176388.1262 | | 0 | Hotspot | |
| 572574.3362 | 4176391.7903 | | 0 | Hotspot | |
| 572569.8172 | 4176387.6988 | | 0 | Hotspot | |
| 572565.2983 | 4176383.6073 | | 0 | Hotspot | |

Primary Sampling Objective

The primary purpose of sampling at this site is to detect "hot spots" (local areas of elevated concentration) of a given size and shape with a specified probability, $1-\beta$.

Selected Sampling Approach

This sampling approach requires systematic grid sampling with a random start. If a systematic grid is not used, the probability of detecting a hot spot of a given size and shape will be different than desired or calculated.

Number of Total Samples: Calculation Equation and Inputs

The algorithm used to calculate the grid size (and hence, the number of samples) is based on work by Singer for locating geologic deposits [see Singer (1972, 1975) and PNNL-13450 for details]. Inputs to the algorithm include the size, shape, and orientation of a hot spot of interest, an acceptable probability of not finding a hot spot, the desired type of sampling grid, and the sampling budget. For this design, the grid size was calculated based on a given hot spot size and other parameters.

The inputs to the algorithm that result in the grid size are:

| Parameter | Description | Value |
|----------------------------|---|-------------------------|
| Inputs | | |
| $1-\beta$ | Probability of detection | 95% |
| Grid Type | Grid pattern (Square, Triangular or Rectangular) | Square |
| Hot Spot Shape | Hot spot height to width ratio | 1 |
| Hot Spot Size | Length of hot spot semi-major axis | 11 feet |
| Hot Spot Area ^a | Area of hot spot ($\text{Length}^2 * \text{Shape} * \pi$) | 380.133 ft ² |
| Angle | Angle of orientation between hot spot and grid | Random |
| Sampling Area | Total area to sample | 208.64 m ² |
| Outputs | | |
| Grid Size | Length of side of grid | 20 feet |
| Grid Area | Area covered by one grid cell | 400 ft ² |
| Samples ^b | Optimum number of samples | 6.66077 |

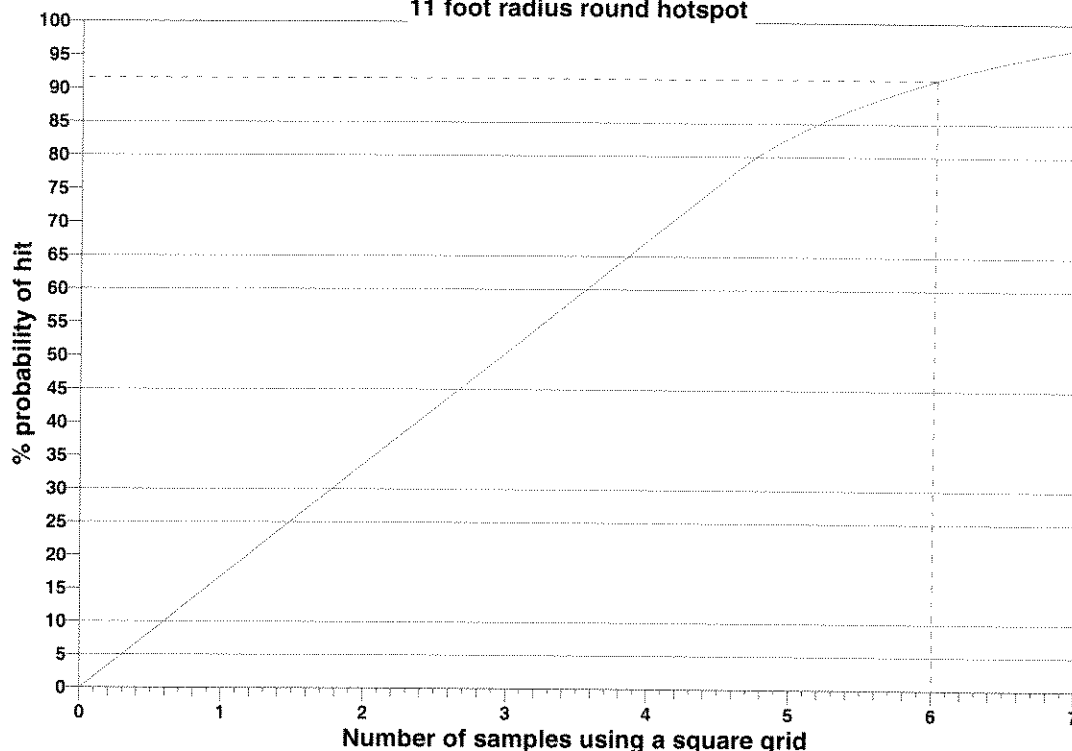
^a Length of semi-major axis is used by algorithm. Hot spot area is provided for informational purposes.

^b The optimum number of samples is calculated by dividing the sampling area by the grid area.

The following graph shows the relationship between number of samples and the probability of finding the hot spot. The dashed blue line shows the actual number of samples for this design (which may differ from the optimum number of samples because of edge effects).

Hotspot Sampling of 208.642 Meters²

11 foot radius round hotspot



Statistical Assumptions

The assumptions associated with the sample spacing algorithm are that:

1. the target hot spot (its projection onto the coordinate plane) is circular or elliptical,
2. samples are taken on a square, rectangular, or triangular grid,
3. a very small proportion of the area being studied will be sampled (the sample is much smaller than the hot spot of interest),
4. the level of contamination that classifies a hot spot is well defined, and
5. there are no misclassification errors (a hot spot is not mistakenly overlooked or an area is not mistakenly identified as a hot spot).

These assumptions cannot be validated through data collection. The size and shape of a hot spot of interest are well defined prior to determining the number of samples and the measured value that defines a hot spot is well above the detection limit for the analytical methods that will be used. Grid sampling will be carried out to the level achievable; topographic, vegetative, and other features that prevent sampling at the specified coordinates will be noted and their influence recognized.

Sensitivity Analysis

The sensitivity of the calculation of number of samples was explored by varying Area and Side and examining the resulting changes in the number of samples. The following table shows the results of this analysis.

| Number of Samples | | | |
|-------------------|---------|---------|---------|
| | Side=10 | Side=20 | Side=30 |
| Area=104.321 | 4 | 4 | 4 |
| Area=208.642 | 7 | 7 | 7 |
| Area=312.963 | 10 | 10 | 10 |

Area = Total Sampling Area

Side = Length of Grid Side

Cost of Sampling

The total cost of the completed sampling program depends on several cost inputs, some of which are fixed, and others

that are based on the number of samples collected and measured. Based on the numbers of samples determined above, the estimated total cost of sampling and analysis at this site is ~~\$4500.00~~, which averages out to a per sample cost of ~~\$642.86~~. The following table summarizes the inputs and resulting cost estimates.

| COST INFORMATION | | | |
|--|--------------|-----------------|------------------|
| Cost Details | Per Analysis | Per Sample | 7 Samples |
| Field collection costs | | \$100.00 | \$700.00 |
| Analytical costs | \$400.00 | \$400.00 | \$2800.00 |
| Sum of Field & Analytical costs | | \$500.00 | \$3500.00 |
| Fixed planning and validation costs | | | \$1000.00 |
| Total cost | | | \$4500.00 |

Recommended Data Analysis Activities

Post data collection activities generally follow those outlined in EPA's Guidance for Data Quality Assessment (EPA, 2000). The data analysts will become familiar with the context of the problem and goals for data collection and assessment. The data will be verified and validated before being subjected to statistical or other analyses. Graphical and analytical tools will be used to verify to the extent possible the assumptions of any statistical analyses that are performed as well as to achieve a general understanding of the data. The data will be assessed to determine whether they are adequate in both quality and quantity to support the primary objective of sampling.

A map of the actual sample locations will be generated so that the sampling plan and the field implementation may be compared. Deviations from planned sample locations due to topographic, vegetative, or other features will be noted. Their impacts will be qualitatively assessed. If a hot spot is discovered, additional sampling may be performed to determine its size and shape, in which case, the initial assumptions of the sampling design may then be assessed and/or reconsidered.

This report was automatically produced* by Visual Sample Plan (VSP) software version 4.0a.

Software and documentation available at <http://dco.pnl.gov/vsp>

Software copyright (c) 2005 Battelle Memorial Institute. All rights reserved.

* - The report contents may have been modified or reformatted by end-user of software.

APPENDIX E

STANDARD OPERATING PROCEDURES



MODEL 5400 GEOPROBE™ OPERATION

SOP#: 2050
DATE: 03/27/96
REV. #: 0.0

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to describe the collection of representative soil, soil-gas, and groundwater samples using a Model 5400 Geoprobe™ sampling device. Any deviations from these procedures should be documented in the site/field logbook and stated in project deliverables.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (U.S. EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

The Geoprobe™ sampling device is used to collect soil, soil-gas and groundwater samples at specific depths below ground surface (BGS). The Geoprobe™ is hydraulically powered and is mounted in a customized four-wheel drive vehicle. The base of the sampling device is positioned on the ground over the sampling location and the vehicle is hydraulically raised on the base. As the weight of the vehicle is transferred to the probe, the probe is pushed into the ground. A built-in hammer mechanism allows the probe to be driven through dense materials. Maximum depth penetration under favorable circumstances is about 50 feet. Components of the Model 5400 Geoprobe™ are shown in Figures 1 through 6 (Appendix A).

Soil samples are collected with a specially-designed sample tube. The sample tube is pushed and/or vibrated to a specified depth (approximately one foot above the intended sample interval). The interior plug of the sample tube is removed by inserting small-diameter threaded rods. The sample tube is then driven an additional foot to collect the samples. The probe sections and sample tube are then withdrawn and the sample is extruded from the tube into sample jars.

Soil gas can be collected in two ways. One method

involves withdrawing a sample directly from the probe rods, after evacuating a sufficient volume of air from the probe rods. The other method involves collecting a sample through tubing attached by an adaptor to the bottom probe section. Correctly used, the latter method provides more reliable results.

Slotted lengths of probe can be used to collect groundwater samples if the probe rods can be driven to the water table. Groundwater samples are collected using either a peristaltic pump or a small bailer.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING AND STORAGE

Refer to specific ERT SOPs for procedures appropriate to the matrix, parameters and sampling objector.

Applicable ERT SOPs include:

ERT #2012, Soil Sampling

ERT #2007, Groundwater Well Sampling

ERT #2042, Soil Gas Sampling

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

A preliminary site survey should identify areas to be avoided with the truck. All underground utilities should be located and avoided during sampling. Begin sampling activities with an adequate fuel supply.

Decontamination of sampling tubes, probe rods, adaptors, non-expendable points and other equipment that contacts the soil is necessary to prevent cross-contamination of samples. During sampling, the bottom portion and outside of the sampling tubes can be contaminated with soil from other depth intervals.

Care must be taken to prevent soil which does not represent the sampled interval from being incorporated into the sample. Excess soil should be carefully wiped from the outside surface of the sampling tube and the bottom 3 inches of the sample should be discarded before extruding the sample into a sample jar.

The amount of sample to be collected and the proper sample container type (i.e., glass, plastic), chemical preservation, and storage requirements are dependent upon the parameter(s) of interest. Guidelines for the containment, preservation, handling and storage of soil-gas samples are described in ERT SOP #2042, Soil-Gas Sampling.

Obtaining sufficient volume of soil for multiple analyses from one sample location may present a problem. The Geoprobe™ soil sampling system recovers a limited volume of soil and it is not possible to reenter the same hole and collect additional soil. When multiple analyses are to be performed on soil samples collected with the Geoprobe™, it is important that the relative importance of the analyses be identified. Identifying the order of importance will ensure that the limited sample volume will be used for the most crucial analyses.

5.0 EQUIPMENT/APPARATUS

Sampling with the Geoprobe™ involves use of the equipment listed below. Some of the equipment is used for all sample types, others are specific to soil (S), soil gas (SG), or groundwater (GW) as noted.

- C Geoprobe™ sampling device
- C Threaded probe rods (36", 24", and 12" lengths)
- C Drive Caps
- C Pull Caps
- C Rod Extractor
- C Expendable Point Holders
- C Expendable Drive Points
- C Solid Drive Points
- C Extension Rods
- C Extension Rod Couplers
- C Extension Rod Handle
- C Hammer Anvil
- C Hammer Latch
- C Hammer Latch Tool
- C Drill Steels
- C Carbide-Tipped Drill Bit

- C Mill-Slotted Well Point (GW)
- C Threaded Drive Point (GW)
- C Well Mini-Bailer (GW)
- C Tubing Bottom Check Valve (GW)
- C 3/8" O.D. Low Density Polyethylene Tubing (GW, SG)
- C Gas Sampling Adaptor and Cap (SG)
- C Teflon Tape
- C Neoprene "O" - Rings (SG)
- C Vacuum System (mounted in vehicle) (SG)
- C Piston Tip (S)
- C Piston Rod (S)
- C Piston Stop (S)
- C Sample Tube (11.5" in length) (S)
- C Vinyl Ends Caps (S)
- C Sample Extruder (S)
- C Extruder Pistons (Wooden Dowels) (S)
- C Wire Brush
- C Brush Adapters
- C Cleaning Brush (Bottle)

6.0 REAGENTS

Decontamination solutions are specified in ERT SOP #2006, Sampling Equipment Decontamination.

7.0 PROCEDURES

Portions of the following sections have been condensed from the Model 5400 Geoprobe™ Operations Manual(1). Refer to this manual for more detailed information concerning equipment specifications, general maintenance, tools, throttle control, clutch pump, GSK-58 Hammer, and trouble-shooting. A copy of this manual will be maintained with the Geoprobe™ and on file in the Quality Assurance (QA) office.

7.1 Preparation

1. Determine extent of the sampling effort, sample matrices to be collected, and types and amounts of equipment and supplies required to complete the sampling effort.
2. Obtain and organize necessary sampling and monitoring equipment.
3. Decontaminate or pre-clean equipment, and ensure that it is in working order.
4. Perform a general site survey prior to site

entry in accordance with the site-specific Health and Safety Plan.

5. Use stakes or flagging to identify and mark all sampling locations. All sample locations should be cleared for utilities prior to sampling.

7.2 Setup of Geoprobe™

1. Back carrier vehicle to probing location.
2. Shift the vehicle to park and shut off ignition.
3. Set parking brake and place chocks under rear tires.
4. Attach exhaust hoses so exhaust blows downwind of the sampling location (this is particularly important during soil gas sampling).
5. Start engine using the remote ignition at the Geoprobe™ operator position.
6. Activate hydraulic system by turning on the Electrical Control Switch located on the Geoprobe™ electrical control panel (Figure 1, Appendix A). When positioning the probe, always use the SLOW speed. The SLOW speed switch is located on the hydraulic control panel (Figure 2, Appendix A).

Important: Check for clearance on vehicle roof before folding Geoprobe™ out of the carrier vehicle.

7. Laterally extend the Geoprobe™ from the vehicle as far as possible by pulling the EXTEND control lever toward the back of the vehicle while the Geoprobe™ is horizontal.
8. Using the FOOT control, lower the Derrick Slide so it is below cylinder (A) before folding the Geoprobe™ out of the carrier vehicle (Figure 3, Appendix A). This will ensure clearance at the roof of the vehicle.
9. Use the FOLD, FOOT, and EXTEND controls to place Geoprobe™ to the exact

probing location. Never begin probing in the fully extended position.

10. Using the FOLD control, adjust the long axis of the probe cylinder so that it is perpendicular (visually) to the ground surface.
11. Using the FOOT control, put the weight of the vehicle on the probe unit. Do not raise the rear of the vehicle more than six inches.

Important: Keep rear vehicle wheels on the ground surface when transferring the weight of the vehicle to the probe unit. Otherwise, vehicle may shift when probing begins.

12. When the probe axis is vertical and the weight of the vehicle is on the probe unit, probing is ready to begin.

7.3 Drilling Through Surface Pavement or Concrete

1. Position carrier vehicle to drilling location.
2. Fold unit out of carrier vehicle.
3. Deactivate hydraulics.
4. Insert carbide-tipped drill bit into hammer.
5. Activate HAMMER ROTATION control by turning knob counter-clockwise (Figure 4, Appendix A). This allows the drill bit to rotate when the HAMMER control is pressed.
6. Press down on HAMMER control to activate counterclockwise rotation.
7. Both the HAMMER control and the PROBE control must be used when drilling through the surface (Figure 4, Appendix A). Fully depress the HAMMER control, and incrementally lower the bit gradually into the pavement by periodically depressing the PROBE control.
8. When the surface has been penetrated, turn the HAMMER Control Valve knob

clockwise to deactivate hammer rotation and remove the drill bit from the HAMMER.

Important: Be sure to deactivate the rotary action before driving probe rods.

7.4 Probing

1. Position the carrier vehicle to the desired sampling location and set the vehicle parking brake.
2. Deploy Geoprobe™ Sampling Device.
3. Make sure the hydraulic system is turned off.
4. Lift up latch and insert hammer anvil into hammer - push latch back in (Figure 5, Appendix A).
5. Thread the drive cap onto the male end of the probe rod.
6. Thread an expendable point holder onto the other end of the first probe rod.
7. Slip an expendable drive point into point holder.
8. Position the leading probe rod with expendable drive point in the center of the derrick foot and directly below the hammer anvil.

Important: Positioning the first probe rod is critical in order to drive the probe rod vertically. Therefore, both the probe rod and the probe cylinder shaft must be in the vertical position (Figure 6, Appendix A).

9. To begin probing, activate the hydraulics and push the PROBE Control downward. When advancing the first probe rod, always use the SLOW speed. Many times the probe rods can be advanced using only the weight of the carrier vehicle. When this is the case, only the PROBE control is used.

Important: When advancing rods, always keep the probe rods parallel to the probe cylinder shaft (Figure 6, Appendix A).

This is done by making minor adjustments with the FOLD control. Failure to keep probe rods parallel to probe cylinder shaft may result in broken rods and increased difficulty in achieving desired sampling depth.

7.5 Probing - Percussion Hammer

The percussion hammer must be used in situations where the weight of the vehicle is not sufficient to advance the probe rods.

1. Make sure the Hammer Rotation Valve is closed.
 2. Using the PROBE control to advance the rod, press down the HAMMER control to allow percussion to drive the rods (Figure 2, Appendix A).
- Important: Always keep static weight on the probe rod or the rod will vibrate and chatter while you are hammering, causing rod threads to fracture and break.**
3. Keep the hammer tight to the drive cap so the rod will not vibrate.
 4. Periodically stop hammering and check if the probe rods can be advanced by pushing only.
 5. Any time the downward progress of the probe rods is refused, the derrick foot may lift off of the ground surface. When this happens, reduce pressure on the PROBE control. Do not allow the foot to rise more than six inches off the ground or the vehicle's wheels may lift off the ground surface, causing the vehicle to shift (Figure 6, Appendix A).
 6. As the derrick foot is raised off the ground surface, the probe cylinder may not be in a perpendicular position. If this happens, use the FOLD control to correct the probe cylinder position.

7.6 Probing - Adding Rods

1. Standard probe rods are three feet in length. If the desired depth is more than three feet,

another rod must be threaded onto the rod that has been driven into the ground. In order to ensure a vacuum-tight seal (soil-gas sampling), two wraps of teflon tape around the thread is recommended.

2. Using the PROBE control, raise the probe cylinder as high as possible.

Important: Always deactivate hydraulics when adding rods.

3. Deactivate hydraulics.
4. Unthread the drive cap from the probe rod that is in the ground.
5. Wrap teflon tape around the threads.
6. Thread the drive cap onto the male end of the next probe rod to be used.
7. After threading the drive cap onto the rod to be added, thread the rod onto the probe rod that has been driven into the ground. Make sure threads have been teflon taped. Continue probing.
8. Continue these steps until the desired sampling depth has been reached.

7.7 Probing/Pulling Rods

1. Once the probe rods have been driven to depth, they can also be pulled using the Geoprobe™ Machine.
2. Turn off the hydraulics.
3. Lift up latch and take the hammer anvil out of the hammer.
4. Replace the drive cap from the last probe rod driven with a pull cap.
5. Lift up the hammer latch.
6. Activate the hydraulics.
7. Hold down on the PROBE control, and move the probe cylinder down until the latch can be closed over the pull cap.

Important: If the latch will not close over the pull cap, adjust the derrick assembly by using the extend control. This will allow you to center the pull cap directly below the hammer latch.

8. Retract the probe rods by pulling up on the PROBE control.

Important: Do not raise the probe cylinder all the way when pulling probe rods or it will be impossible to detach a rod that has been pulled out. However, it is necessary to raise the probe cylinder far enough to allow the next probe section to be pulled.

9. After retracting the first probe rod, lower the probe cylinder only slightly to ease the pressure off of the hammer latch.
10. Attach a clamping device to the base of the rods where it meets the ground to prevent rods from falling back into the hole.
11. Raise the hammer latch.
12. Hold the PROBE control up and raise the probe cylinder as high as possible.
13. Unthread the pull cap from the retracted rod.
14. Unthread the retracted rod.
15. Thread the pull cap onto the next rod that is to be pulled.
16. Continue these steps until all the rods are retracted from the hole.
17. Decontaminate all portions of the equipment that have been in contact with the soil, soil gas and groundwater.

7.8 Soil-Gas Sampling Without Interior Tubing

1. Follow procedures outlined in Sections 7.1 through 7.6.
2. Remove hammer anvil from hammer.

3. Thread on pull cap to end of probe rod.
4. Retract rod approximately six inches. Retraction of the rod disengages expendable drive point and allows for soil vapor to enter rod.
5. Unthread pull cap and replace it with a gas sampling cap. Cap is furnished with barbed hose connector.

Important: Shut engine off before taking sample (exhaust fumes can cause faulty sample data).

6. Turn vacuum pump on and allow vacuum to build in tank.
7. Open line control valve. For each rod used, purge 300 liters of volume. Example: Three rods used = 900 liters = .900 on gauge.
8. After achieving sufficient purge volume, close valve and allow sample line pressure gauge to return to zero. This returns sample train to atmospheric pressure.
9. The vapor sample can now be taken.
 1. Pinch hose near gas sampling cap to prevent any outside vapors from entering the rods.
 2. Insert syringe needle into center of barbed hose connector and withdraw vapor sample.
10. To maintain suction at the sampling location, periodically drain the vacuum tank.
11. To remove rods, follow procedures outlined in Section 7.7.

7.9 Soil-Gas Sampling With Post-Run Tubing (PRT)

1. Follow procedures outlined in Sections 7.1 through 7.6.

2. Retract rod approximately six inches. Retraction of rod disengages expendable drive point and allows for soil vapor to enter rod.
3. Remove pull cap from the end of the probe rod.
4. Position the Geoprobe™ to allow room to work.
5. Secure PRT Tubing Adapter with "O" - Ring to selected tubing.
6. Insert the adapter end of the tubing down the inside diameter of the probe rods.
7. Feed the tubing down the hole until it hits bottom on the expendable point holder. Cut the tubing approximately two feet from the top probe rod.
8. Grasp excess tubing and apply some downward pressure while turning it in a counter-clockwise motion to engage the adapter threads with the expendable point holder.
9. Pull up lightly on the tubing to test engagement of threads.
10. Connect the outer end of the tubing to silicon tubing and vacuum hose (or other sampling apparatus).
11. Follow the appropriate sampling procedure (ERT SOP #2042, Soil Gas Sampling) to collect a soil-gas sample.
12. After collecting a sample, disconnect the tubing from the vacuum hose or sampling system.
13. Pull up firmly on the tubing until it releases from the adapter at the bottom of the hole.
14. Extract the probe rods from the ground and recover the expendable point holder with the attached adapter.

15. Inspect the "O"-ring at the base of the adapter to verify that proper sealing was achieved during sampling. The "O"-ring should be compressed.

Note: If the "O"-ring is not compressed, vapors from within the probe sections may have been collected rather than vapors from the intended sample interval.

7.10 Soil Sampling

1. Follow procedures outlined in Sections 7.1 through 7.6.
2. Assemble soil-sampling tube.
 1. Thread piston rod into piston tip.
 2. Insert piston tip into sample tube, seating piston tip into cutting edge of sample tube.
 3. Thread drive head into threaded end of sample tube.
 4. Thread piston stop pin into drive head. Stop pin should be tightened with wrench so that it exerts pressure against the piston rod.
3. Attach assembled sampler onto leading probe rod.
4. Drive the sampler with the attached probe rods to the top of the interval to be sampled.
5. Move probe unit back from the top of the probe rods to allow work room.
6. Remove drive cap and lower extension rods into inside diameter of probe rods using couplers to join rods together.
7. Attach extension rod handle to top extension rod.
8. Rotate extension rod handle clockwise until the leading extension rod is threaded into the piston stop in downhole.
9. Continue to rotate extension rod handle clockwise until reverse-threaded stop-pin has disengaged from the drive head.

10. Remove extension rods and attached stop-pin from the probe rods.
11. Replace drive cap onto top probe rod.
12. Mark the top probe rod with a marker or tape at the appropriate distance above the ground surface (dependent on sample tube length).
13. Drive probe rods and sampler the designated distance. Be careful not to overdrive the sampler which could compact the soil sample in the tube, making it difficult to extrude.

Important: Documentation of sample location should include both surface and subsurface identifiers. Example: Correct Method - Sample Location S-6, 12.0' - 13.0'. Incorrect Method - Sample Location S-6, 12.0'.

14. Retract probe rods from the hole and recover the sample tube. Inspect the sample tube to confirm that a sample was recovered.
 15. Disassemble sampler. Remove all parts.
 16. Position extruder rack on the foot of the Geoprobe™ derrick.
 17. Insert sample tube into extruder rack with the cutting end up.
 18. Insert hammer anvil into hammer.
 19. Position the extruder piston (wood dowel) and push sample out of the tube using the PROBE control on the Geoprobe™. Collect the sample as it is extruded in an appropriate sample container.
- Caution: use care when performing this task. Apply downward pressure gradually. Use of excessive force could result in injury to operator or damage to tools. Make sure proper diameter extruder piston is used.**
20. To remove rods follow procedures outlined in Section 7.7.

7.11 Groundwater Sampling

1. Follow Sections 7.1 through 7.6 with the following exception: the Mill-Slotted Well Rod with attached threaded drive point should be the first section probed into the ground. Multiple sections of mill-slotted well rods can be used to provide a greater vertical section into which groundwater can flow.
2. Probe to a depth at which groundwater is expected.
3. Remove Drive Cap and insert an electric water-level indicator to determine if water has entered the slotted sections of probe rod. Refer to ERT SOP #2043, Water Level Measurement, to determine water level.
4. If water is not detected in the probe rods, replace the drive cap and continue probing. Stop after each additional probe length and determine if groundwater has entered the slotted rods.
5. After the probe rods have been driven into the saturated zone, sufficient time should be allowed for the water level in the probe rods to stabilize.

Note: It will be difficult if not impossible to collect a groundwater sample in aquifer material small enough to pass through the slots (<0.02 inch diameter).

6. Groundwater samples may be collected with the 20-mL well Mini-Bailer or a pumping device. If samples are being collected for volatile organic analysis (VOA), the 20-mL Well Mini-Bailer should be used. If samples are being collected for a variety of analyses, VOA samples should be collected first using the bailer. Remaining samples can be collected by pumping water to the surface. Withdrawing water with the pump is more efficient than collecting water with the 20-mL well Mini-Bailer.

Important: Documentation of sample location should include both surface and subsurface identifiers. Example: Sample Location GW-6, 17'-21' bgs, water level in

probe rods is 17 feet bgs, and the leading section of probe rod is 21 feet bgs. The water sample is from this zone, not from 17 feet bgs or 21 feet bgs.

7. Remove rods following procedures outlined in Section 7.7.

8.0 CALCULATIONS

Calculating Vapor Purge Volume for Soil-Gas Sampling without Interior Tubing

Volume of Air to be Purged (Liters) = 300 x
Number of Rods in the Ground

Volume in Liters/1000 = Reading on
Vacuum Pump Instrument Gauge

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

The following general QA procedures apply:

1. All data must be documented on field data sheets or within site logbooks.
2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation and they must be documented.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA and the REAC site specific Health and Safety Plan. The following is a list of health and safety precautions which specifically apply to Geoprobe™ operation.

1. Always put vehicle in "park", set emergency the brake, and place chocks under the tires, before engaging remote ignition.

2. If vehicle is parked on a loose or soft surface, do not fully raise rear of vehicle with probe foot, as vehicle may fall or move.
3. Always extend the probe unit out from the vehicle and deploy the foot to clear vehicle roof line before folding the probe unit out.
4. Operators should wear OSHA approved steel-toed shoes and keep feet clear of probe foot.
5. Operator should wear ANSI approved hard hats.
6. Only one person should operate the probe machine and the assemble or disassemble probe rods and accessories.
7. Never place hands on top of a rod while it is under the machine.
8. Turn off the hydraulic system while changing rods, inserting the hammer anvil, or attaching accessories.
9. Operator must stand on the control side of the probe machine, clear of the probe foot and mast, while operating controls.
10. Wear safety glasses at all times during the operation of this machine.
11. Never continue to exert downward pressure on the probe rods when the probe foot has risen six inches off the ground.
12. Never exert enough downward pressure on a probe rod so as to lift the rear tires of the vehicle off the ground.
13. Always remove the hammer anvil or other tool from the machine before folding the machine to the horizontal position.
14. The vehicle catalytic converter is hot and may present a fire hazard when operating over dry grass or combustibles.
15. Geoprobe™ operators must wear ear protection. OSHA approved ear protection for sound levels exceeding 85 dba is recommended.
16. Locations of buried or underground utilities and services must be known before starting to drill or probe.
17. Shut down the hydraulic system and stop the vehicle engine before attempting to clean or service the equipment.
18. Exercise extreme caution when using extruder pistons (wooden dowels) to extrude soil from sample tubes. Soil in the sample tube may be compacted to the point that the extruder piston will break or shatter before it will push the sample out.
19. A dry chemical fire extinguisher (Type ABC) should be kept with the vehicle at all times.

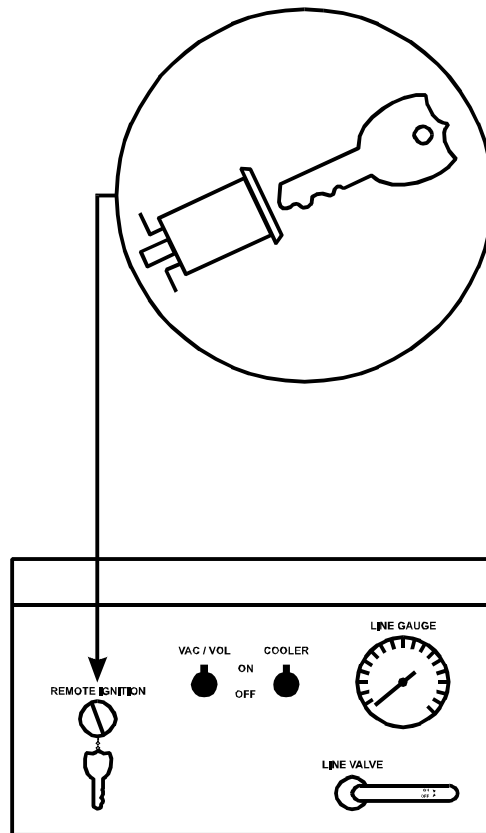
12.0 REFERENCES

1. Model 5400 Geoprobe™ Operations Manual. Geoprobe™ Systems, Salina, Kansas. July 27, 1990.
2. Geoprobe™ Systems - 1995-96 Tools and Equipment Catalog.

APPENDIX A

Figures

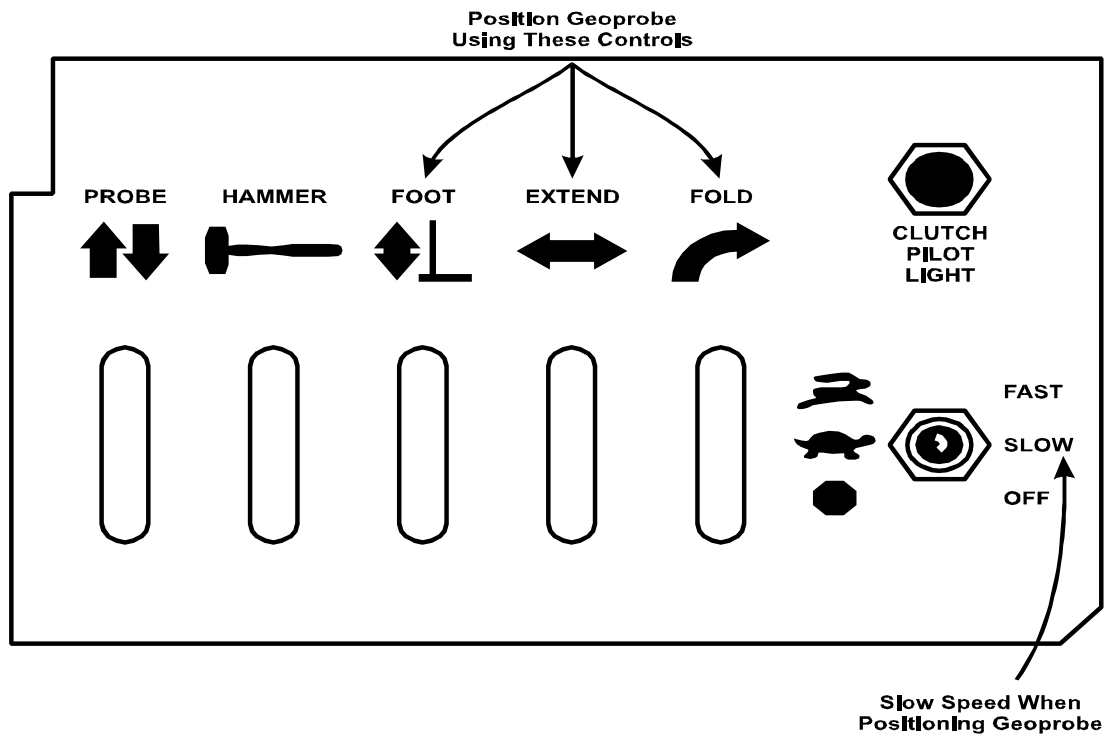
FIGURE 1. Electrical Control Panel



APPENDIX A (Cont'd)

Figures

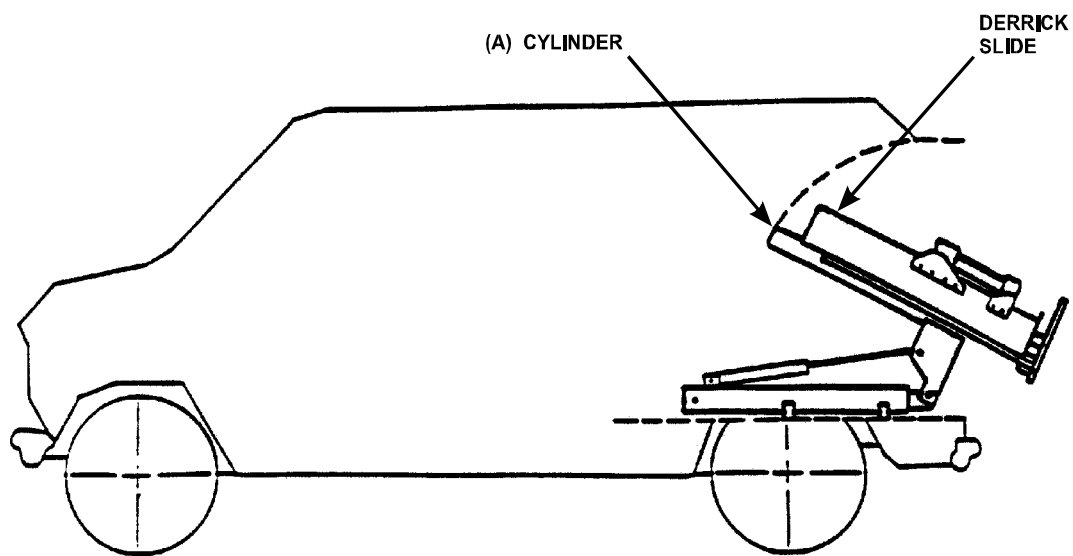
FIGURE 2. Hydraulic Control Panel



APPENDIX A (Cont'd)

Figures

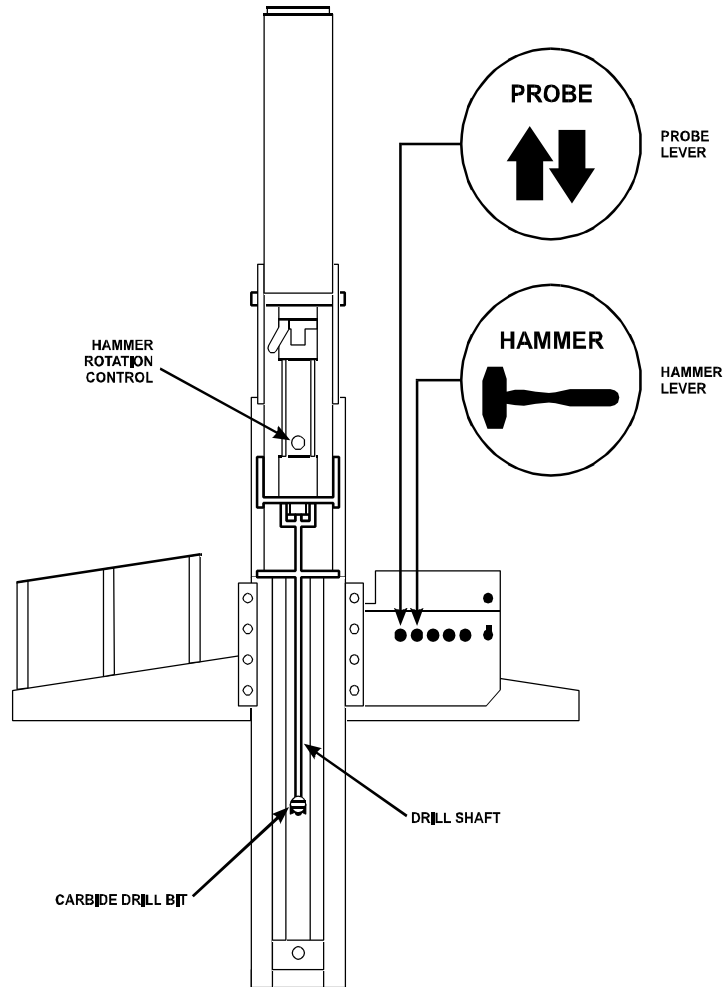
FIGURE 3. Deployment of Geoprobe™ from Sampling Vehicle



APPENDIX A (Cont'd)

Figures

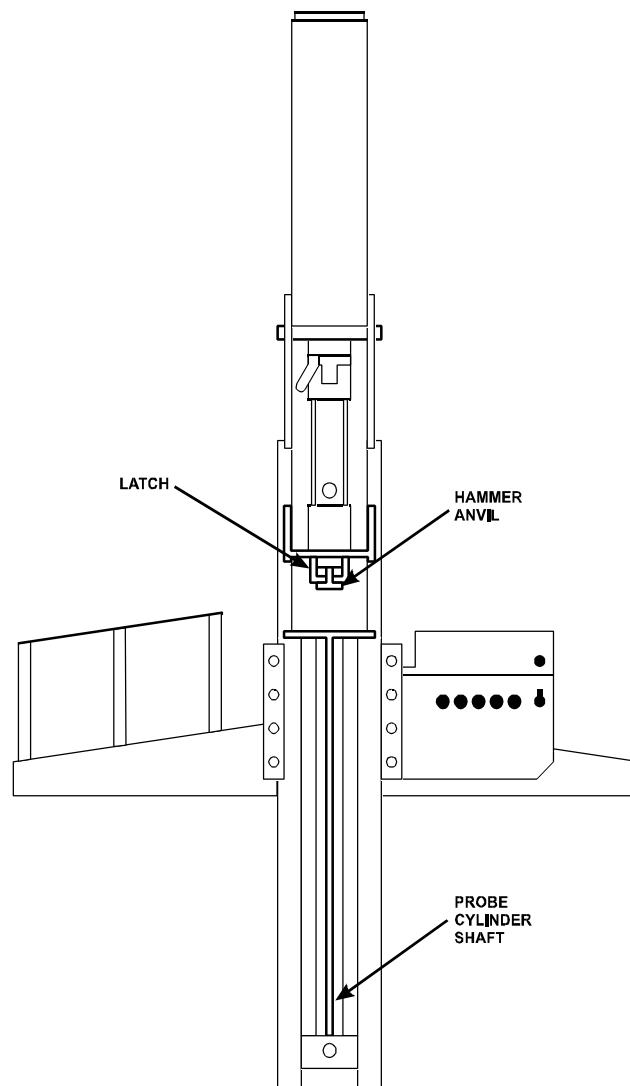
FIGURE 4. Geoprobe™ Setup for Drilling Through Concrete and Pavement



APPENDIX A (Cont'd)

Figures

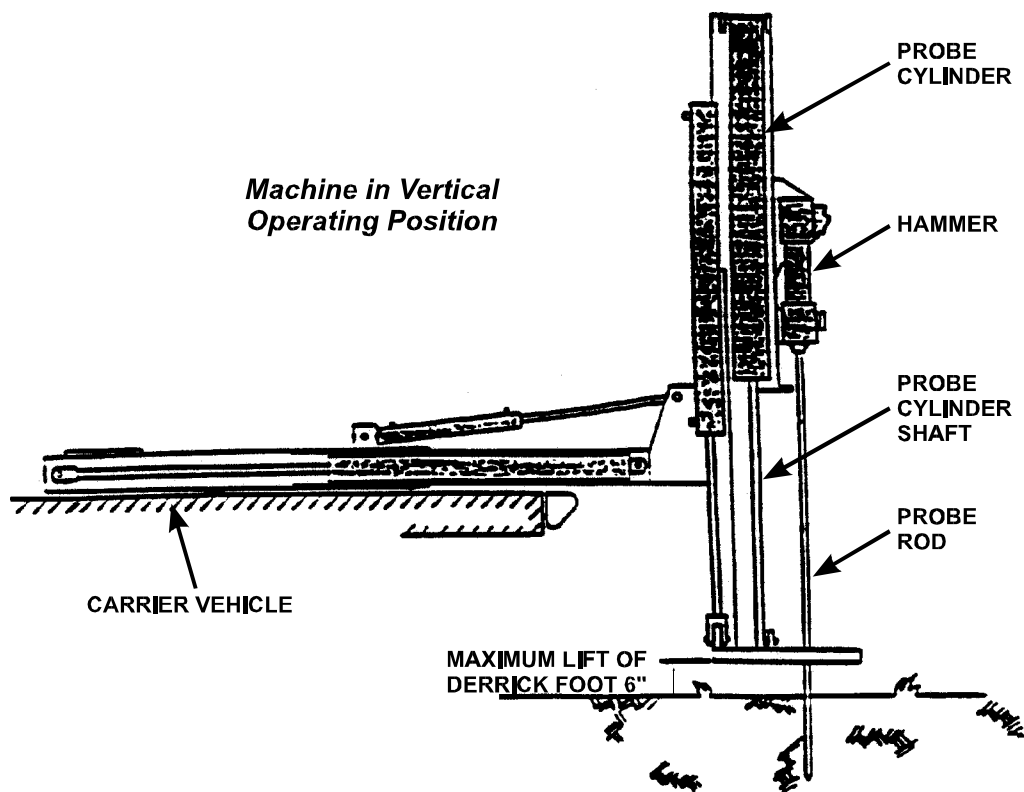
FIGURE 5. Inserting Hammer Anvil



APPENDIX A (Cont'd)

Figures

FIGURE 6. Probe Cylinder Shaft and Probe Rod - Parallel and Vertical





U. S. EPA ENVIRONMENTAL RESPONSE TEAM

STANDARD OPERATING PROCEDURES

SOP: 2012
PAGE: 1 of 13
REV: 0.0
DATE: 02/18/00

SOIL SAMPLING

CONTENTS

| | |
|-------|---|
| 1.0 | SCOPE AND APPLICATION |
| 2.0 | METHOD SUMMARY |
| 3.0 | SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE |
| 4.0 | POTENTIAL PROBLEMS |
| 5.0 | EQUIPMENT |
| 6.0 | REAGENTS |
| 7.0 | PROCEDURES |
| 7.1 | Preparation |
| 7.2 | Sample Collection |
| 7.2.1 | Surface Soil Samples |
| 7.2.2 | Sampling at Depth with Augers and Thin Wall Tube Samplers |
| 7.2.3 | Sampling at Depth with a Trier |
| 7.2.4 | Sampling at Depth with a Split Spoon (Barrel) Sampler |
| 7.2.5 | Test Pit/Trench Excavation |
| 8.0 | CALCULATIONS |
| 9.0 | QUALITY ASSURANCE/QUALITY CONTROL |
| 10.0 | DATA VALIDATION |
| 11.0 | HEALTH AND SAFETY |
| 12.0 | REFERENCES |
| 13.0 | APPENDIX |
| | Figures |



U. S. EPA ENVIRONMENTAL RESPONSE TEAM

STANDARD OPERATING PROCEDURES

SOP: 2012
PAGE: 2 of 13
REV: 0.0
DATE: 02/18/00

SOIL SAMPLING

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to describe the procedures for the collection of representative soil samples. Sampling depths are assumed to be those that can be reached without the use of a drill rig, direct-push, or other mechanized equipment (except for a back-hoe). Analysis of soil samples may determine whether concentrations of specific pollutants exceed established action levels, or if the concentrations of pollutants present a risk to public health, welfare, or the environment.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the actual procedures used should be documented and described in an appropriate site report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

Soil samples may be collected using a variety of methods and equipment depending on the depth of the desired sample, the type of sample required (disturbed vs. undisturbed), and the soil type. Near-surface soils may be easily sampled using a spade, trowel, and scoop. Sampling at greater depths may be performed using a hand auger, continuous flight auger, a trier, a split-spoon, or, if required, a backhoe.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Chemical preservation of solids is not generally recommended. Samples should, however, be cooled and protected from sunlight to minimize any potential reaction. The amount of sample to be collected and proper sample container type are discussed in ERT/REAC SOP #2003 Rev. 0.0 08/11/94, *Sample Storage, Preservation and Handling*.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

There are two primary potential problems associated with soil sampling - cross contamination of samples and improper sample collection. Cross contamination problems can be eliminated or minimized through the use of dedicated sampling equipment. If this is not possible or practical, then decontamination of sampling equipment is necessary. Improper sample collection can involve using contaminated equipment, disturbance of the matrix resulting in compaction of the sample, or inadequate homogenization of the samples where required, resulting in variable, non-representative results.

5.0 EQUIPMENT



U. S. EPA ENVIRONMENTAL RESPONSE TEAM

STANDARD OPERATING PROCEDURES

SOP: 2012
PAGE: 3 of 13
REV: 0.0
DATE: 02/18/00

SOIL SAMPLING

Soil sampling equipment includes the following:

- Maps/plot plan
- Safety equipment, as specified in the site-specific Health and Safety Plan
- Survey equipment or global positioning system (GPS) to locate sampling points
- Tape measure
- Survey stakes or flags
- Camera and film
- Stainless steel, plastic, or other appropriate homogenization bucket, bowl or pan
- Appropriate size sample containers
- Ziplock plastic bags
- Logbook
- Labels
- Chain of Custody records and custody seals
- Field data sheets and sample labels
- Cooler(s)
- Ice
- Vermiculite
- Decontamination supplies/equipment
- Canvas or plastic sheet
- Spade or shovel
- Spatula
- Scoop
- Plastic or stainless steel spoons
- Trowel(s)
- Continuous flight (screw) auger
- Bucket auger
- Post hole auger
- Extension rods
- T-handle
- Sampling trier
- Thin wall tube sampler
- Split spoons
- Vehimeyer soil sampler outfit
 - Tubes
 - Points
 - Drive head
 - Drop hammer
 - Puller jack and grip
- Backhoe



U. S. EPA ENVIRONMENTAL RESPONSE TEAM

STANDARD OPERATING PROCEDURES

SOP: 2012
PAGE: 4 of 13
REV: 0.0
DATE: 02/18/00

SOIL SAMPLING

Reagents are not used for the preservation of soil samples. Decontamination solutions are specified in ERT/REAC SOP #2006 Rev. 0.0 08/11/94, *Sampling Equipment Decontamination*, and the site specific work plan.

7.0 PROCEDURES

7.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies required.
2. Obtain necessary sampling and monitoring equipment.
3. Decontaminate or pre-clean equipment, and ensure that it is in working order.
4. Prepare schedules and coordinate with staff, client, and regulatory agencies, if appropriate.
5. Perform a general site survey prior to site entry in accordance with the site specific Health and Safety Plan.
6. Use stakes, flagging, or buoys to identify and mark all sampling locations. Specific site factors, including extent and nature of contaminant, should be considered when selecting sample location. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions. All staked locations should be utility-cleared by the property owner or the On-Scene-Coordinator (OSC) prior to soil sampling; and utility clearance should always be confirmed before beginning work.

7.2 Sample Collection

7.2.1 Surface Soil Samples

Collection of samples from near-surface soil can be accomplished with tools such as spades, shovels, trowels, and scoops. Surface material is removed to the required depth and a stainless steel or plastic scoop is then used to collect the sample.

This method can be used in most soil types but is limited to sampling at or near the ground surface. Accurate, representative samples can be collected with this procedure depending on the care and precision demonstrated by the sample team member. A flat, pointed mason trowel to cut a block of the desired soil is helpful when undisturbed profiles are required. Tools plated with chrome or other materials should not be used. Plating is particularly common with garden implements such as potting trowels.

The following procedure is used to collect surface soil samples:



U. S. EPA ENVIRONMENTAL RESPONSE TEAM

STANDARD OPERATING PROCEDURES

SOP: 2012
PAGE: 5 of 13
REV: 0.0
DATE: 02/18/00

SOIL SAMPLING

1. Carefully remove the top layer of soil or debris to the desired sample depth with a pre-cleaned spade.
2. Using a pre-cleaned, stainless steel scoop, plastic spoon, or trowel, remove and discard a thin layer of soil from the area which came in contact with the spade.
3. If volatile organic analysis is to be performed, transfer the sample directly into an appropriate, labeled sample container with a stainless steel lab spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval or location into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.

7.2.2 Sampling at Depth with Augers and Thin Wall Tube Samplers

This system consists of an auger, or a thin-wall tube sampler, a series of extensions, and a "T" handle (Figure 1, Appendix A). The auger is used to bore a hole to a desired sampling depth, and is then withdrawn. The sample may be collected directly from the auger. If a core sample is to be collected, the auger tip is then replaced with a thin wall tube sampler. The system is then lowered down the borehole, and driven into the soil to the completion depth. The system is withdrawn and the core is collected from the thin wall tube sampler.

Several types of augers are available; these include: bucket type, continuous flight (screw), and post-hole augers. Bucket type augers are better for direct sample recovery because they provide a large volume of sample in a short time. When continuous flight augers are used, the sample can be collected directly from the flights. The continuous flight augers are satisfactory when a composite of the complete soil column is desired. Post-hole augers have limited utility for sample collection as they are designed to cut through fibrous, rooted, swampy soil and cannot be used below a depth of approximately three feet.

The following procedure is used for collecting soil samples with the auger:

1. Attach the auger bit to a drill rod extension, and attach the "T" handle to the drill rod.



U. S. EPA ENVIRONMENTAL RESPONSE TEAM

STANDARD OPERATING PROCEDURES

SOP: 2012
PAGE: 6 of 13
REV: 0.0
DATE: 02/18/00

SOIL SAMPLING

2. Clear the area to be sampled of any surface debris (e.g., twigs, rocks, litter). It may be advisable to remove the first three to six inches of surface soil for an area approximately six inches in radius around the drilling location.
3. Begin augering, periodically removing and depositing accumulated soils onto a plastic sheet spread near the hole. This prevents accidental brushing of loose material back down the borehole when removing the auger or adding drill rods. It also facilitates refilling the hole, and avoids possible contamination of the surrounding area.
4. After reaching the desired depth, slowly and carefully remove the auger from the hole. When sampling directly from the auger, collect the sample after the auger is removed from the hole and proceed to Step 10.
5. Remove auger tip from the extension rods and replace with a pre-cleaned thin wall tube sampler. Install the proper cutting tip.
6. Carefully lower the tube sampler down the borehole. Gradually force the tube sampler into the soil. Do not scrape the borehole sides. Avoid hammering the rods as the vibrations may cause the boring walls to collapse.
7. Remove the tube sampler, and unscrew the drill rods.
8. Remove the cutting tip and the core from the device.
9. Discard the top of the core (approximately 1 inch), as this possibly represents material collected before penetration of the layer of concern. Place the remaining core into the appropriate labeled sample container. Sample homogenization is not required.
10. If volatile organic analysis is to be performed, transfer the sample into an appropriate, labeled sample container with a stainless steel lab spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval into the homogenization container and mix thoroughly.

When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.



U. S. EPA ENVIRONMENTAL RESPONSE TEAM

STANDARD OPERATING PROCEDURES

SOP: 2012
PAGE: 7 of 13
REV: 0.0
DATE: 02/18/00

SOIL SAMPLING

11. If another sample is to be collected in the same hole, but at a greater depth, reattach the auger bit to the drill and assembly, and follow steps 3 through 11, making sure to decontaminate the auger and tube sampler between samples.
12. Abandon the hole according to applicable state regulations. Generally, shallow holes can simply be backfilled with the removed soil material.

7.2.3 Sampling with a Trier

The system consists of a trier, and a "T" handle. The auger is driven into the soil to be sampled and used to extract a core sample from the appropriate depth.

The following procedure is used to collect soil samples with a sampling trier:

1. Insert the trier (Figure 2, Appendix A) into the material to be sampled at a 0° to 45° angle from horizontal. This orientation minimizes the spillage of sample.
2. Rotate the trier once or twice to cut a core of material.
3. Slowly withdraw the trier, making sure that the slot is facing upward.
4. If volatile organic analyses are required, transfer the sample into an appropriate, labeled sample container with a stainless steel lab spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.

7.2.4 Sampling at Depth with a Split Spoon (Barrel) Sampler

Split spoon sampling is generally used to collect undisturbed soil cores of 18 or 24 inches in length. A series of consecutive cores may be extracted with a split spoon sampler to give a complete soil column profile, or an auger may be used to drill down to the desired depth for sampling. The split spoon is then driven to its sampling depth through the bottom of the augured hole and the core extracted.

When split spoon sampling is performed to gain geologic information, all work should



U. S. EPA ENVIRONMENTAL RESPONSE TEAM

STANDARD OPERATING PROCEDURES

SOP: 2012
PAGE: 8 of 13
REV: 0.0
DATE: 02/18/00

SOIL SAMPLING

be performed in accordance with ASTM D1586-98, "Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils".

The following procedures are used for collecting soil samples with a split spoon:

1. Assemble the sampler by aligning both sides of barrel and then screwing the drive shoe on the bottom and the head piece on top.
2. Place the sampler in a perpendicular position on the sample material.
3. Using a well ring, drive the tube. Do not drive past the bottom of the head piece or compression of the sample will result.
4. Record in the site logbook or on field data sheets the length of the tube used to penetrate the material being sampled, and the number of blows required to obtain this depth.
5. Withdraw the sampler, and open by unscrewing the bit and head and splitting the barrel. The amount of recovery and soil type should be recorded on the boring log. If a split sample is desired, a cleaned, stainless steel knife should be used to divide the tube contents in half, longitudinally. This sampler is typically available in 2 and 3 1/2 inch diameters. A larger barrel may be necessary to obtain the required sample volume.
6. Without disturbing the core, transfer it to appropriate labeled sample container(s) and seal tightly.

7.2.5 Test Pit/Trench Excavation

A backhoe can be used to remove sections of soil, when detailed examination of soil characteristics are required. This is probably the most expensive sampling method because of the relatively high cost of backhoe operation.

The following procedures are used for collecting soil samples from test pits or trenches:

1. Prior to any excavation with a backhoe, it is important to ensure that all sampling locations are clear of overhead and buried utilities.
2. Review the site specific Health & Safety plan and ensure that all safety precautions including appropriate monitoring equipment are installed as required.



U. S. EPA ENVIRONMENTAL RESPONSE TEAM

STANDARD OPERATING PROCEDURES

SOP: 2012
PAGE: 9 of 13
REV: 0.0
DATE: 02/18/00

SOIL SAMPLING

3. Using the backhoe, excavate a trench approximately three feet wide and approximately one foot deep below the cleared sampling location. Place excavated soils on plastic sheets. Trenches greater than five feet deep must be sloped or protected by a shoring system, as required by OSHA regulations.
4. A shovel is used to remove a one to two inch layer of soil from the vertical face of the pit where sampling is to be done.
5. Samples are taken using a trowel, scoop, or coring device at the desired intervals. Be sure to scrape the vertical face at the point of sampling to remove any soil that may have fallen from above, and to expose fresh soil for sampling. In many instances, samples can be collected directly from the backhoe bucket.
6. If volatile organic analyses are required, transfer the sample into an appropriate, labeled sample container with a stainless steel lab spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.
7. Abandon the pit or excavation according to applicable state regulations. Generally, shallow excavations can simply be backfilled with the removed soil material.

8.0 CALCULATIONS

This section is not applicable to this SOP.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

There are no specific quality assurance (QA) activities which apply to the implementation of these procedures. However, the following QA procedures apply:

1. All data must be documented on field data sheets or within site logbooks.
2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration



U. S. EPA ENVIRONMENTAL RESPONSE TEAM

STANDARD OPERATING PROCEDURES

SOP: 2012
PAGE: 10 of 13
REV: 0.0
DATE: 02/18/00

SOIL SAMPLING

activities must occur prior to sampling/operation, and they must be documented.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OHSA and corporate health and safety procedures, in addition to the procedures specified in the site specific Health & Safety Plan..

12.0 REFERENCES

Mason, B.J. 1983. Preparation of Soil Sampling Protocol: Technique and Strategies. EPA-600/4-83-020.

Barth, D.S. and B.J. Mason. 1984. Soil Sampling Quality Assurance User's Guide. EPA-600/4-84-043.

U.S. Environmental Protection Agency. 1984 Characterization of Hazardous Waste Sites - A Methods Manual: Volume II. Available Sampling Methods, Second Edition. EPA-600/4-84-076.

de Vera, E.R., B.P. Simmons, R.D. Stephen, and D.L. Storm. 1980. Samplers and Sampling Procedures for Hazardous Waste Streams. EPA-600/2-80-018.

ASTM D 1586-98, ASTM Committee on Standards, Philadelphia, PA.



U. S. EPA ENVIRONMENTAL RESPONSE TEAM

STANDARD OPERATING PROCEDURES

SOP: 2012
PAGE: 11 of 13
REV: 0.0
DATE: 02/18/00

SOIL SAMPLING

APPENDIX A

Figures
SOP #2012
February 2000



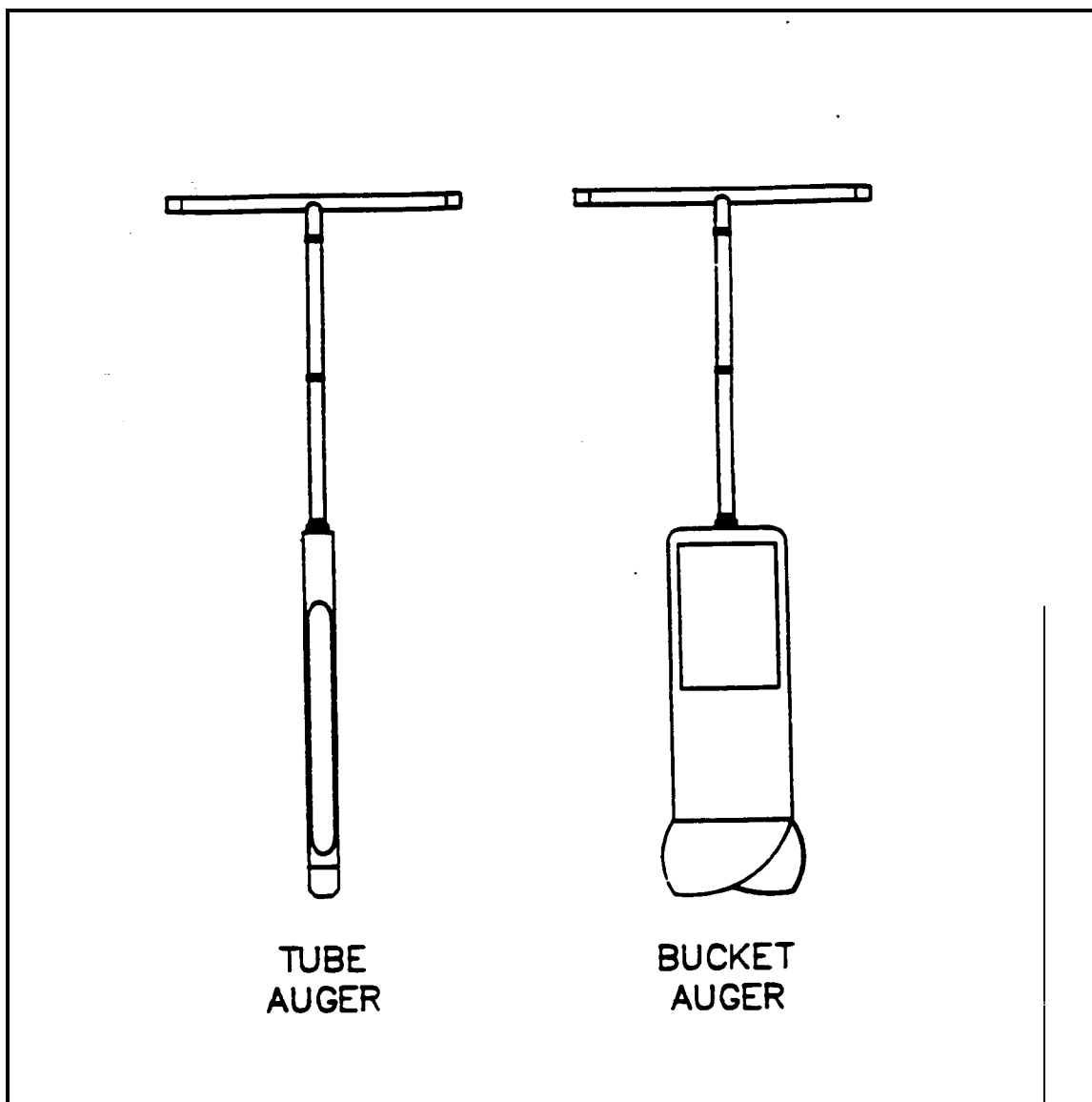
U. S. EPA ENVIRONMENTAL RESPONSE TEAM

STANDARD OPERATING PROCEDURES

SOP: 2012
PAGE: 12 of 13
REV: 0.0
DATE: 02/18/00

SOIL SAMPLING

FIGURE 1. Sampling Augers





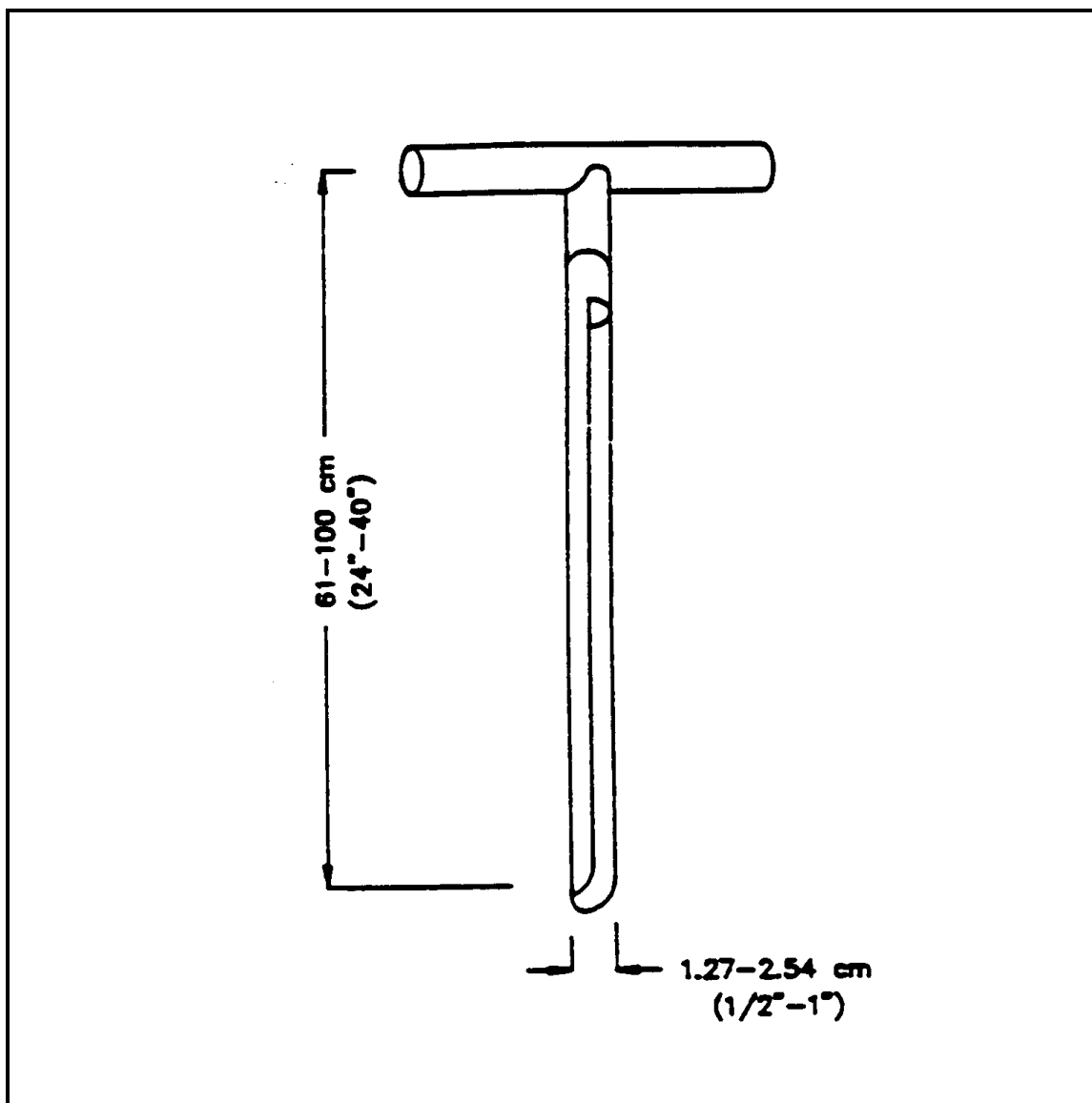
U. S. EPA ENVIRONMENTAL RESPONSE TEAM

STANDARD OPERATING PROCEDURES

SOP: 2012
PAGE: 13 of 13
REV: 0.0
DATE: 02/18/00

SOIL SAMPLING

FIGURE 2. Sampling Trier





GROUNDWATER WELL SAMPLING

SOP#: 2007
DATE: 01/26/95
REV. #: 0.0

1.0 SCOPE AND APPLICATION

The objective of this standard operating procedure (SOP) is to provide general reference information on sampling of ground water wells. This guideline is primarily concerned with the collection of water samples from the saturated zone of the subsurface. Every effort must be made to ensure that the sample is representative of the particular zone of water being sampled. These procedures are designed to be used in conjunction with analyses for the most common types of ground water contaminants (e.g., volatile and semi-volatile organic compounds, pesticides, metals, biological parameters).

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

In order to obtain a representative groundwater sample for chemical analysis it is important to remove stagnant water in the well casing and the water immediately adjacent to the well before collection of the sample. This may be achieved with one of a number of instruments. The most common of these are the bailer, submersible pump, non-contact gas bladder pump, inertia pump and suction pump. At a minimum, three well volumes should be purged, if possible. Equipment must be decontaminated prior to use and between wells. Once purging is completed and the correct laboratory-cleaned sample containers have been prepared, sampling may proceed. Sampling may be conducted with any of the above instruments,

and need not be the same as the device used for purging. Care should be taken when choosing the sampling device as some will affect the integrity of the sample. Sampling should occur in a progression from the least to most contaminated well, if this information is known.

The growing concern over the past several years over low levels of volatile organic compounds in water supplies has led to the development of highly sophisticated analytical methods that can provide detection limits at part per trillion levels. While the laboratory methods are extremely sensitive, well controlled and quality assured, they cannot compensate for a poorly collected sample. The collection of a sample should be as sensitive, highly developed and quality assured as the analytical procedures.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

The type of analysis for which a sample is being collected determines the type of bottle, preservative, holding time, and filtering requirements. Samples should be collected directly from the sampling device into appropriate laboratory cleaned containers. Check that a Teflon liner is present in the cap, if required. Attach a sample identification label. Complete a field data sheet, a chain of custody form, and record all pertinent data in the site logbook.

Samples shall be appropriately preserved, labelled, logged, and placed in a cooler to be maintained at 4EC. Samples must be shipped well before the holding time is up and ideally should be shipped within 24 hours of sample collection. It is imperative that samples be shipped or delivered daily to the analytical laboratory in order to maximize the time available for the laboratory to perform the analyses. The bottles should be shipped with adequate packing and cooling to ensure that they arrive intact.

Sample retrieval systems suitable for the valid collection of volatile organic samples are: positive displacement bladder pumps, gear driven submersible pumps, syringe samplers and bailers (Barcelona, 1984; Nielsen, 1985). Field conditions and other constraints will limit the choice of appropriate systems. The focus of concern must remain to provide a valid sample for analysis, one which has been subjected to the least amount of turbulence possible.

Treatment of the sample with sodium thiosulfate preservative is required only if there is residual chlorine in the water that could cause free radical chlorination and change the identity of the original contaminants. It should not be used if there is no chlorine in the water.

Holding time for volatiles analysis is seven days. It is imperative that the sample be shipped or delivered daily to the analytical laboratory. The bottles must be shipped on their sides to aid in maintaining the airtight seal during shipment, with adequate packing and cooling to ensure that they arrive intact.

For collection of volatile organic samples, refer to the work plan to ensure that 40 mL glass sample vials with Teflon lined septa are ordered and in sufficient numbers. Check sampling supplies; field kit for chlorine, preservatives, Parafilm, foam sleeves and coolers. Due to the extreme trace levels at which volatile organics are detectable, cross contamination and introduction of contaminants must be avoided. Trip blanks are incorporated into the shipment package to provide a check against cross contamination.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

4.1 General

The primary goal in performing ground water sampling is to obtain a representative sample of the ground water body. Analysis can be compromised by field personnel in two primary ways: (1) taking an unrepresentative sample, or (2) by incorrect handling of the sample. There are numerous ways of introducing foreign contaminants into a sample, and these must be avoided by following strict sampling procedures and utilizing trained field personnel.

4.2 Purging

In a nonpumping well, there will be little or no vertical mixing of the water, and stratification will occur. The well water in the screened section will mix with the ground water due to normal flow patterns, but the well water above the screened section will remain isolated, become stagnant, and may lack the contaminants representative of the ground water. Persons sampling should realize that stagnant water may contain foreign material inadvertently or deliberately introduced from the surface, resulting in an unrepresentative sample. To safeguard against collecting nonrepresentative stagnant water, the following guidelines and techniques should be adhered to during sampling:

1. As a general rule, all monitor wells should be pumped or bailed prior to sampling. Purge water should be containerized on site or handled as specified in the site specific project plan. Evacuation of a minimum of one volume of water in the well casing, and preferably three to five volumes, is recommended for a representative sample. In a high-yielding ground water formation and where there is no stagnant water in the well above the screened section, evacuation prior to sample withdrawal is not as critical. However, in all cases where the monitoring data is to be used for enforcement actions, evacuation is recommended.
2. When purging with a pump (not a bailer), the pump should be set at the screened interval, or if the well is an open-rock well, it should be set at the same depth the sample will be collected. When sampling a screened well, the sample should also be collected from the same depth the pump was set at.
3. The well should be sampled as soon as possible after purging.
4. Analytical parameters typically dictate whether the sample should be collected through the purging device, or through a separate sampling instrument.
5. For wells that can be pumped or bailed to dryness with the equipment being used, the well should be evacuated and allowed to

recover prior to collecting a sample. If the recovery rate is fairly rapid and time allows, evacuation of more than one volume of water is preferred. If recovery is slow, sample the well upon recovery after one evacuation.

6. A non-representative sample can also result from excessive pre-pumping of the monitoring well. Stratification of the leachate concentration in the ground water formation may occur, or heavier-than-water compounds may sink to the lower portions of the aquifer. Excessive pumping can dilute or increase the contaminant concentrations from what is representative of the sampling point of interest.

4.3 Materials

Materials of construction for samplers and evacuation equipment (bladders, pump, bailers, tubing, etc.) should be limited to stainless steel, Teflon[®], and glass in areas where concentrations are expected to be at or near the detection limit. The tendency of organics to leach into and out of many materials make the selection of materials critical for trace analyses. The use of plastics, such as PVC or polyethylene, should be avoided when analyzing for organics. However, PVC may be used for evacuation equipment as it will not come in contact with the sample, and in highly contaminated wells, disposable equipment (i.e., polypropylene bailers) may be appropriate to avoid cross-contamination.

Materials of construction (bladders/ pumps, bailers, tubing, etc.) suitable for collecting and handling Volatile Organic Samples should be limited to stainless steel, Teflon and glass in areas which detection limit range concentrations are expected. The tendency of organics to leach into and out of many materials, make the selection of materials critical for these trace analyses. The use of plastics, e.g., PVC etc., should be avoided. There are numerous ways of introducing foreign contaminants into a sample, and these must be avoided by following strict sampling procedures and utilization of trained personnel.

4.4 Advantages/Disadvantages of Certain Equipment

4.4.1 Bailers

Advantages

- C Only practical limitations on size and materials
- C No power source needed
- C Portable
- C Inexpensive, so it can be dedicated and hung in a well, thereby reducing the chances of cross contamination
- C Minimal outgassing of volatile organics while sample is in bailer
- C Readily available
- C Removes stagnant water first
- C Rapid, simple method for removing small volumes of purge water

Disadvantages

- C Time-consuming to flush a large well of stagnant water
- C Transfer of sample may cause aeration
- C Stoppers at the bottom of the bailer usually leak thus the bailer must be brought to the surface rapidly
- C If the bailer is allowed to hit the bottom of the well boring, gravel can displace the ball valve not allowing the bailer to hold water

4.4.2 Submersible Pumps

Advantages

- C Portable and can be transported to several wells
- C Depending upon the size of the pump and the pumping depths, relatively high pumping rates are possible
- C Generally very reliable and does not require priming

Disadvantages

- C Potential for effects on analysis of trace organics
- C Heavy and cumbersome to deal with, particularly in deeper wells
- C Expensive
- C Power source needed
- C Sediment in water may cause problems with the pumps
- C Impractical in low yielding or shallow wells

4.4.3 Non-Contact Gas Bladder Pumps

Advantages

- C Maintains integrity of sample
- C Easy to use
- C Can sample from discrete locations within the monitor well

Disadvantages

- C Difficulty in cleaning, though dedicated tubing and bladder may be used
- C Only useful to about 100 feet
- C Supply of gas for operation, gas bottles and/or compressors are often difficult to obtain and are cumbersome
- C Relatively low pumping rates
- C Requires air compressor or pressurized gas source and control box

4.4.4 Suction Pumps

Advantages

- C Portable, inexpensive, and readily available

Disadvantages

- C Restricted to areas with water levels within 20 to 25 feet of the ground surface
- C Vacuum can cause loss of dissolved gasses and volatile organics
- C Pump must be primed and vacuum is often difficult to maintain during initial stages of pumping

4.4.5 Inertia Pumps

Advantages

- C Portable, inexpensive, and readily available
- C Offers a rapid method for purging relatively shallow wells

Disadvantages

- C Restricted to areas with water levels within 70 feet of the ground surface
- C May be time consuming to purge wells with these manual pumps
- C Labor intensive
- C WaTerra pumps are only effective in 2-inch diameter wells

5.0 EQUIPMENT APPARATUS

5.1 Equipment Checklist

5.1.1 General

- C Water level indicator
 - electric sounder
 - steel tape
 - transducer
 - reflection sounder
 - airline
- C Depth sounder
- C Appropriate keys for well cap locks
- C Steel brush
- C HNU or OVA (whichever is most appropriate)
- C Logbook
- C Calculator
- C Field data sheets and samples labels

- C Chain of custody records and seals
- C Sample containers
- C Engineer's rule
- C Sharp knife (locking blade)
- C Tool box (to include at least: screwdrivers, pliers, hacksaw, hammer, flashlight, adjustable wrench)
- C Leather work gloves
- C Appropriate Health & Safety gear
- C 5-gallon pail
- C Plastic sheeting
- C Shipping containers
- C Packing materials
- C Bolt cutters
- C Ziploc plastic bags
- C Containers for evacuation liquids
- C Decontamination solutions
- C Tap water
- C Non phosphate soap
- C Several brushes
- C Pails or tubs
- C Aluminum foil
- C Garden sprayer
- C Preservatives
- C Distilled or deionized water
- C Fire extinguisher (if using a generator for your power source)

5.1.2 Bailers

- C Clean, decontaminated bailers of appropriate size and construction material
- C Nylon line, enough to dedicate to each well
- C Teflon coated bailer wire
- C Sharp knife
- C Aluminum foil (to wrap clean bailers)
- C Five gallon bucket

5.1.3 Submersible Pump

- C Pump(s)
- C Generator (110, 120, or 240 volt) or 12 volt battery if inaccessible to field vehicle - amp meter is useful
- C 1" black PVC coil tubing - enough to dedicate to each well
- C Hose clamps
- C Safety cable
- C Tool box supplement
 - pipe wrenches

- wire strippers
- electrical tape
- heat shrink
- hose connectors
- Teflon tape

- C Winch, pulley or hoist
- C Gasoline for generator/gas can
- C Flow meter with gate valve
- C 1" nipples and various plumbing (i.e., pipe connectors)
- C Control box (if necessary)

5.1.4 Non-Gas Contact Bladder Pump

- C Non-gas contact bladder pump
- C Compressor or nitrogen gas tank
- C Batteries and charger
- C Teflon tubing - enough to dedicate to each well
- C Swagelock fitting
- C Toolbox supplements - same as submersible pump
- C Control box (if necessary)

5.1.5 Suction Pump

- C Pump
- C 1" black PVC coil tubing - enough to dedicate to each well
- C Gasoline - if required
- C Toolbox
- C Plumbing fittings
- C Flow meter with gate valve

5.1.6 Inertia Pump

- C Pump assembly (WaTerra pump, piston pump)
- C Five gallon bucket

6.0 REAGENTS

Reagents may be utilized for preservation of samples and for decontamination of sampling equipment. The preservatives required are specified by the analysis to be performed. Decontamination solutions are specified in ERT SOP #2006, Sampling Equipment Decontamination.

7.0 PROCEDURE

7.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed (i.e., diameter and depth of wells to be sampled).
2. Obtain necessary sampling and monitoring equipment, appropriate to type of contaminant being investigated. For collection of volatile organic samples, refer to the work plan to ensure that 40 mL glass sample vials with Teflon lined septa are ordered and in sufficient numbers. Check sampling supplies; field kit for chlorine, preservatives, Parafilm, foam sleeves and coolers. Due to extreme trace levels at which volatile organics are detectable, cross contamination and introduction of contaminants must be avoided. Trip blanks are incorporated into the shipment package to provide a check against cross contamination.
3. Decontaminate or preclean equipment, and ensure that it is in working order.
4. Prepare scheduling and coordinate with staff, clients, and regulatory agency, if appropriate.
5. Perform a general site survey prior to site entry in accordance with the site specific Health and Safety Plan.
6. Identify and mark all sampling locations.

7.2 Field Preparation

1. Start at the least contaminated well, if known.
2. Lay plastic sheeting around the well to minimize likelihood of contamination of equipment from soil adjacent to the well.
3. Remove locking well cap, note location, time of day, and date in field notebook or appropriate log form.
4. Remove well casing cap.

5. Screen headspace of well with an appropriate monitoring instrument to determine the presence of volatile organic compounds and record in site logbook.
6. Lower water level measuring device or equivalent (i.e., permanently installed transducers or airline) into well until water surface is encountered.
7. Measure distance from water surface to reference measuring point on well casing or protective barrier post and record in site logbook. Alternatively, if no reference point, note that water level measurement is from top of steel casing, top of PVC riser pipe, from ground surface, or some other position on the well head.

If floating organics are of concern, this can be determined by measuring the water level with an oil/water interface probe which measures floating organics.
8. Measure total depth of well (at least twice to confirm measurement) and record in site logbook or on field data sheet.
9. Calculate the volume of water in the well and the volume to be purged using the calculations in Section 8.0.
10. Select the appropriate purging and sampling equipment.
11. If residual chlorine is suspected, use the Hach Field Test Kit for chlorine to determine if there is residual chlorine in the water to be sampled. If there is, treat the sample vial with a crystal of sodium thiosulfate prior to sample collection.

7.3 Purging

The amount of flushing a well receives prior to sample collection depends on the intent of the monitoring program as well as the hydrogeologic conditions. Programs where overall quality determination of water resources are involved may require long pumping periods to obtain a sample that is representative of a large volume of that aquifer. The pumped volume can be determined prior to sampling so that the sample is

a collected after a known volume of the water is evacuated from the aquifer, or the well can be pumped until the stabilization of parameters such as temperature, electrical conductance, pH, or turbidity has occurred.

However, monitoring for defining a contaminant plume requires a representative sample of a small volume of the aquifer. These circumstances require that the well be pumped enough to remove the stagnant water but not enough to induce flow from other areas. Generally, three well volumes are considered effective, or calculations can be made to determine, on the basis of the aquifer parameters and well dimensions, the appropriate volume to remove prior to sampling.

During purging, water level measurements may be taken regularly at 15-30 second intervals. This data may be used to compute aquifer transmissivity and other hydraulic characteristics. The following well evacuation devices are most commonly used. Other evacuation devices are available, but have been omitted in this discussion due to their limited use.

7.3.1 Bailers

Bailers are the simplest purging device used and have many advantages. They generally consist of a rigid length of tube, usually with a ball check-valve at the bottom. A line is used to lower the bailer into the well and retrieve a volume of water. The three most common types of bailer are PVC, Teflon, and stainless steel.

This manual method of purging is best suited to shallow or narrow diameter wells. For deep, larger diameter wells which require evacuation of large volumes of water, other mechanical devices may be more appropriate.

7.3.1.1 Operation

Equipment needed will include a clean decontaminated bailer, Teflon or nylon line, a sharp knife, and plastic sheeting.

1. Determine the volume of water to be purged as described in 8.0, calculations.
2. Lay plastic sheeting around the well to prevent contamination of the bailer line with

foreign materials.

3. Attach the line to the bailer and slowly lower until the bailer is completely submerged, being careful not to drop the bailer to the water, causing turbulence and the possible loss of volatile organic contaminants.
4. Pull bailer out ensuring that the line either falls onto a clean area of plastic sheeting or never touches the ground.
5. Empty the bailer into a pail until full to determine the number of bails necessary to achieve the required purge volume.
6. Thereafter, pour the water into a container and dispose of purge waters as specified in the site specific sampling plan.

7.3.2 Submersible Pumps

The use of submersible pumps for sample collection is permissible provided they are constructed of suitably noncontaminating materials. The chief drawback, however, is the difficulty avoiding cross-contamination between wells. Although some units can be disassembled easily to allow surfaces contacted by contaminants to be cleaned, field decontamination may be difficult and require solvents that can affect sample analysis. The use of submersible pumps in multiple well-sampling programs, therefore, should be carefully considered against other sampling mechanisms (bailers, bladder pumps). In most cases, a sample can be collected by bailer after purging with a submersible pump, however, submersible pumps may be the only practical sampling device for extremely deep wells (greater than 300 feet of water). Under those conditions, dedicated pump systems should be installed to eliminate the potential for cross-contamination of well samples.

Submersible pumps generally use one of two types of power supplies, either electric or compressed gas or air. Electric powered pumps can run off a 12 volt DC rechargeable battery, or a 110 or 220 volt AC power supply. Those units powered by compressed air normally use a small electric or gas-powered air compressor. They may also utilize compressed gas (i.e., nitrogen) from bottles. Different size pumps are available for different depth or diameter monitoring wells.

7.3.2.1 Operation

1. Determine the volume of water to be purged as described in 8.0 Calculations.
2. Lay plastic sheeting around the well to prevent contamination of pumps, hoses or lines with foreign materials.
3. Assemble pump, hoses and safety cable, and lower the pump into the well. Make sure the pump is deep enough so all the water is not evacuated. (Running the pump without water may cause damage.)
4. Attach flow meter to the outlet hose to measure the volume of water purged.
5. Use a ground fault circuit interrupter (GFCI) or ground the generator to avoid possible electric shock.
6. Attach power supply, and purge the well until the specified volume of water has been evacuated (or until field parameters, such as temperature, pH, conductivity, etc, have stabilized). Do not allow the pump to run dry. If the pumping rate exceeds the well recharge rate, lower the pump further into the well, and continue pumping.
7. Collect and dispose of purge waters as specified in the site specific sampling plan.

7.3.3 Non-Contact Gas Bladder Pumps

For this procedure, an all stainless-steel and Teflon Middleburg-squeeze bladder pump (e.g., IEA, TIMCO, Well Wizard, Geoguard, and others) is used to provide the least amount of material interference to the sample (Barcelona, 1985). Water comes into contact with the inside of the bladder (Teflon) and the sample tubing, also Teflon, that may be dedicated to each well. Some wells may have permanently installed bladder pumps, (i.e., Well Wizard, Geoguard), that will be used to sample for all parameters.

7.3.3.1 Operation

1. Assemble Teflon tubing, pump and charged control box.
2. Procedure for purging with a bladder pump is

the same as for a submersible pump (Section 7.3.2.1).

3. Be sure to adjust flow rate to prevent violent jolting of the hose as sample is drawn in.

7.3.4 Suction Pumps

There are many different types of suction pumps. They include: centrifugal, peristaltic and diaphragm. Diaphragm pumps can be used for well evacuation at a fast pumping rate and sampling at a low pumping rate. The peristaltic pump is a low volume pump that uses rollers to squeeze the flexible tubing thereby creating suction. This tubing can be dedicated to a well to prevent cross contamination. Peristaltic pumps, however, require a power source.

7.3.4.1 Operation

1. Assembly of the pump, tubing, and power source if necessary.
2. Procedure for purging with a suction pump is exactly the same as for a submersible pump (Section 7.3.2.1).

7.3.5 Inertia Pumps

Inertia pumps such as the WaTerra pump and piston pump, are manually operated. They are most appropriate to use when wells are too deep to bail by hand, or too shallow or narrow (or inaccessible) to warrant an automatic (submersible, etc.) pump. These pumps are made of plastic and may be either decontaminated or discarded.

7.3.5.1 Operation

1. Determine the volume of water to be purged as described in 8.0, Calculations.
2. Lay plastic sheeting around the well to prevent contamination of pumps or hoses with foreign materials.
3. Assemble pump and lower to the appropriate depth in the well.
4. Begin pumping manually, discharging water into a 5 gallon bucket (or other graduated vessel). Purge until specified volume of water has been evacuated (or until field parameters such as temperature, pH,

conductivity, etc. have stabilized).

5. Collect and dispose of purge waters as specified in the site specific project plan.

7.4 Sampling

Sample withdrawal methods require the use of pumps, compressed air, bailers, and samplers. Ideally, purging and sample withdrawal equipment should be completely inert, economical to manufacture, easily cleaned, sterilized, reusable, able to operate at remote sites in the absence of power resources, and capable of delivering variable rates for sample collection.

There are several factors to take into consideration when choosing a sampling device. Care should be taken when reviewing the advantages or disadvantages of any one device. It may be appropriate to use a different device to sample than that which was used to purge. The most common example of this is the use of a submersible pump to purge and a bailer to sample.

7.4.1 Bailers

The positive-displacement volatile sampling bailer is perhaps the most appropriate for collection of water samples for volatile analysis. Other bailer types (messenger, bottom fill, etc.) are less desirable, but may be mandated by cost and site conditions.

7.4.1.1 Operation

1. Surround the monitor well with clean plastic sheeting. If using the GPI bailer, insert a vial into the claim and assemble the unit.
2. Attach a line to a clean decontaminated bailer.
3. Lower the bailer slowly and gently into the well, taking care not to shake the casing sides or to splash the bailer into the water. Stop lowering at a point adjacent to the screen.
4. Allow bailer to fill and then slowly and gently retrieve the bailer from the well avoiding contact with the casing, so as not to knock flakes of rust or other foreign materials into the bailer. If using the GPI bailer for collecting volatile organic samples,

once at the surface, remove the bailer from the cable. Carefully open the GPI bailer unit and remove the vial. Begin slowly pouring from the bailer, and collect the duplicate samples from the midstream sample.

5. Remove the cap from the sample container and place it on the plastic sheet or in a location where it won't become contaminated. See Section 7.7 for special considerations on VOA samples.
6. Begin slowly pouring from the bailer.
7. Filter and preserve samples as required by sampling plan.
8. Cap the sample container tightly and place prelabeled sample container in a carrier.
9. Replace the well cap.
10. Log all samples in the site logbook and on field data sheets and label all samples.
11. Package samples and complete necessary paperwork.
12. Transport sample to decontamination zone for preparation for transport to analytical laboratory.

7.4.2 Submersible Pumps

Although it is recommended that samples not be collected with a submersible pump due to the reasons stated in Section 4.4.2, there are some situations where they may be used.

7.4.2.1 Operation

1. Allow the monitor well to recharge after purging, keeping the pump just above screened section.
2. Attach gate valve to hose (if not already fitted), and reduce flow of water to a manageable sampling rate.
3. Assemble the appropriate bottles.
4. If no gate valve is available, run the water

- down the side of a clean jar and fill the sample bottles from the jar.
5. Cap the sample container tightly and place prelabeled sample container in a carrier.
 6. Replace the well cap.
 7. Log all samples in the site logbook and on the field data sheets and label all samples.
 8. Package samples and complete necessary paperwork.
 9. Transport sample to decontamination zone for preparation for transport to the analytical laboratory.
 10. Upon completion, remove pump and assembly and fully decontaminate prior to setting into the next sample well. Dedicate the tubing to the hole.

7.4.3 Non-Contact Gas Bladder Pumps

The use of a non-contact gas positive displacement bladder pump is often mandated by the use of dedicated pumps installed in wells. These pumps are also suitable for shallow (less than 100 feet) wells. They are somewhat difficult to clean, but may be used with dedicated sample tubing to avoid cleaning. These pumps require a power supply and a compressed gas supply (or compressor). They may be operated at variable flow and pressure rates making them ideal for both purging and sampling.

Barcelona (1984) and Nielsen (1985) report that the non-contact gas positive displacement pumps cause the least amount of alteration in sample integrity as compared to other sample retrieval methods.

7.4.3.1 Operation

1. Allow well to recharge after purging.
2. Assemble the appropriate bottles.
3. Turn pump on, increase the cycle time and reduce the pressure to the minimum that will allow the sample to come to the surface.
4. Cap the sample container tightly and place

prelabeled sample container in a carrier.

5. Replace the well cap.
6. Log all samples in the site logbook and on field data sheets and label all samples.
7. Package samples and complete necessary paperwork.
8. Transport sample to decontamination zone for preparation for transport to analytical laboratory.
9. On completion, remove the tubing from the well and either replace the Teflon tubing and bladder with new dedicated tubing and bladder or rigorously decontaminate the existing materials.
10. Nonfiltered samples shall be collected directly from the outlet tubing into the sample bottle.
11. For filtered samples, connect the pump outlet tubing directly to the filter unit. The pump pressure should remain decreased so that the pressure build up on the filter does not blow out the pump bladder or displace the filter. For the Geotech barrel filter, no actual connections are necessary so this is not a concern.

7.4.4 Suction Pumps

In view of the limitations of these type pumps, they are not recommended for sampling purposes.

7.4.5 Inertia Pumps

Inertia pumps may be used to collect samples. It is more common, however, to purge with these pumps and sample with a bailer (Section 7.4.1).

7.4.5.1 Operation

1. Following well evacuation, allow the well to recharge.
2. Assemble the appropriate bottles.
3. Since these pumps are manually operated,

the flow rate may be regulated by the sampler. The sample may be discharged from the pump outlet directly into the appropriate sample container.

4. Cap the sample container tightly and place prelabeled sample container in a carrier.
5. Replace the well cap.
6. Log all samples in the site logbook and on field data sheets and label all samples.
7. Package samples and complete necessary paperwork.
8. Transport sample to decontamination zone for preparation for transport to the analytical laboratory.
9. Upon completion, remove pump and decontaminate or discard, as appropriate.

7.4.6. Sample Retrieval - Syringe

A limited number of commercial syringe type samplers are available, (IEA, TIMCO, etc.) some are homemade devices. These devices are claimed to provide good quality samples for volatile analysis, but are severely limited in sample volume and are specific to sampling for volatiles. Essentially, they operated with an evacuated chamber that is lowered down the well, and allowed to fill with the pressure of the water. The entire mechanism is then brought to the surface with the sample. The sample may then be transferred to a sample vial, or the entire unit may be sent as the sample container.

1. Evacuate the syringe if necessary, and lower the sampling device to just below the well screen.
2. Remove the constriction from the device and allow the sample to fill the syringe, apply slight suction as necessary.
3. Bring unit to the surface. If necessary, transfer the sample to vials, as outlined in steps 2 through 7 above.

7.5 Filtering

For samples requiring filtering, such as total metals analysis, the filter must be decontaminated prior to and between uses. Filters work by two methods. A barrel filter such as the "Geotech" filter works with a bicycle pump, used to build up positive pressure in the chamber containing the sample which is then forced through the filter paper (minimum size 0.45 μm) into a jar placed underneath. The barrel itself is filled manually from the bailer or directly via the hose of the sampling pump. The pressure must be maintained up to 30 lbs/in² by periodic pumping.

A vacuum type filter involves two chambers; the upper chamber contains the sample and a filter (minimum size 0.45 μm) divides the chambers. Using a hand pump or a Gilian type pump, air is withdrawn from the lower chamber, creating a vacuum and thus causing the sample to move through the filter into the lower chamber where it is drained into a sample jar. Repeated pumping may be required to drain all the sample into the lower chamber. If preservation of the sample is necessary, this should be done after filtering.

7.6 Post Operation

After all samples are collected and preserved, the sampling equipment should be decontaminated prior to sampling another well to prevent cross-contamination of equipment and monitor wells between locations.

1. Decontaminate all equipment.
2. Replace sampling equipment in storage containers.
3. Prepare and transport ground water samples to the laboratory. Check sample documentation and make sure samples are properly packed for shipment.

7.7 Special Considerations for VOA Sampling

The proper collection of a sample for volatile organics requires minimal disturbance of the sample to limit volatilization and therefore a loss of volatiles from the sample.

Sample retrieval systems suitable for the valid collection of volatile organic samples are: positive displacement bladder pumps, gear driven submersible pumps, syringe samplers and bailers (Barcelona, 1984; Nielsen, 1985). Field conditions and other constraints will limit the choice of appropriate systems. The focus of concern must be to provide a valid sample for analysis, one which has been subjected to the least amount of turbulence possible.

The following procedures should be followed:

1. Open the vial, set cap in a clean place, and collect the sample during the middle of the cycle. When collecting duplicates, collect both samples at the same time.
2. Fill the vial to just overflowing. Do not rinse the vial, nor excessively overflow it. There should be a convex meniscus on the top of the vial.
3. Check that the cap has not been contaminated (splashed) and carefully cap the vial. Place the cap directly over the top and screw down firmly. Do not overtighten and break the cap.
4. Invert the vial and tap gently. Observe vial for at least ten (10) seconds. If an air bubble appears, discard the sample and begin again. It is imperative that no entrapped air is in the sample vial.
5. Immediately place the vial in the protective foam sleeve and place into the cooler, oriented so that it is lying on its side, not straight up.
6. The holding time for VOAs is seven days. Samples should be shipped or delivered to the laboratory daily so as not to exceed the holding time. Ensure that the samples remain at 4EC, but do not allow them to freeze.

8.0 CALCULATIONS

If it is necessary to calculate the volume of the well, utilize the following equation:

$$\text{Well volume} = \pi r^2 h (cf) \quad [\text{Equation 1}]$$

where:

$$\begin{aligned} \pi &= \text{pi} \\ r &= \text{radius of monitoring well (feet)} \\ h &= \text{height of the water column (feet)} \\ &\quad [\text{This may be determined by subtracting the depth to water from the total depth of the well as measured from the same reference point.}] \\ cf &= \text{conversion factor (gal/ft}^3\text{) = 7.48 gal/ft}^3 \text{ [In this equation, 7.48 gal/ft}^3 \text{ is the necessary conversion factor.]} \end{aligned}$$

Monitor well diameters are typically 2", 3", 4", or 6". Knowing the diameter of the monitor well, there are a number of standard conversion factors which can be used to simplify the equation above.

The volume, in gallons per linear foot, for various standard monitor well diameters can be calculated as follows:

$$v(\text{gal/ft}) = \pi r^2 (cf) \quad [\text{Equation 2}]$$

where:

$$\begin{aligned} \pi &= \text{pi} \\ r &= \text{radius of monitoring well (feet)} \\ cf &= \text{conversion factor (7.48 gal/ft}^3\text{)} \end{aligned}$$

For a 2" diameter well, the volume per linear foot can be calculated as follows:

$$\begin{aligned} \text{vol/linear ft} &= \pi r^2 (cf) \quad [\text{Equation 2}] \\ &= 3.14 (1/12 \text{ ft})^2 7.48 \text{ gal/ft}^3 \\ &= 0.1632 \text{ gal/ft} \end{aligned}$$

Remember that if you have a 2" diameter well, you must convert this to the radius in feet to be able to use the equation.

The conversion factors for the common size monitor wells are as follows:

| | | | | |
|------------------|--------|--------|--------|--------|
| Well diameter | 2" | 3" | 4" | 6" |
| Volume (gal/ft.) | 0.1632 | 0.3672 | 0.6528 | 1.4688 |

If you utilize the conversion factors above, Equation

1 should be modified as follows:

$$\text{Well volume} = (h)(cf) \quad [\text{Equation 3}]$$

where:

h = height of water column (feet)
 cf = the conversion factor calculated from Equation 2

The well volume is typically tripled to determine the volume to be purged.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

There are no specific quality assurance (QA) activities which apply to the implementation of these procedures. However, the following general QA procedures apply:

1. All data must be documented on field data sheets or within site logbooks.
2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation and they must be documented.
3. The collection of rinsate blanks is recommended to evaluate potential for cross contamination from the purging and/or sampling equipment.
4. Trip blanks are required if analytical parameters include VOAs.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA or REAC health and safety guidelines. More specifically, depending upon the site specific contaminants, various protective programs

must be implemented prior to sampling the first well. The site health and safety plan should be reviewed with specific emphasis placed on the protection program planned for the well sampling tasks. Standard safe operating practices should be followed such as minimizing contact with potential contaminants in both the vapor phase and liquid matrix through the use of respirators and disposable clothing.

When working around volatile organic contaminants:

1. Avoid breathing constituents venting from the well.
2. Pre-survey the well head-space with an FID/PID prior to sampling.
3. If monitoring results indicate organic constituents, sampling activities may be conducted in Level C protection. At a minimum, skin protection will be afforded by disposable protective clothing.

Physical hazards associated with well sampling:

1. Lifting injuries associated with pump and bailers retrieval; moving equipment.
2. Use of pocket knives for cutting discharge hose.
3. Heat/cold stress as a result of exposure to extreme temperatures and protective clothing.
4. Slip, trip, fall conditions as a result of pump discharge.
5. Restricted mobility due to the wearing of protective clothing.
6. Electrical shock associated with use of submersible pumps is possible. Use a GFCI or a copper grounding stake to avoid this problem.

12.0 REFERENCES

Barcelona, M.J., Helfrich, J.A., Garske, E.E., and J.P. Gibb, Spring 1984. "A Laboratory Evaluation of Groundwater Sampling Mechanisms," Groundwater

Monitoring Review, 1984 pp. 32-41.

Barcelona, M.J., Helfrich, J.A., and Garske, E.E., "Sampling Tubing Effects on Groundwater Samples", *Analy. Chem.*, Vol. 57, 1985 pp. 460-463.

Driscoll, F.G., *Groundwater and Wells* (2nd ed.) Johnson Division, UOP Inc., St. Paul, Minnesota, 1986, 1089 pp.

Gibb, J.P., R.M. Schuller, and R.A. Griffin., *Monitoring Well Sampling and Preservation Techniques*, EPA-600/9-80-010, 1980. March, 1980.

Instrument Specialties Company, (January). *Instruction Manual, Model 2100 Wastewater Sampler*, Lincoln, Nebraska, 1980.

Keely, J.F. and Kwasi Boateng, *Monitoring Well Installation, Purging and Sampling Techniques - Part I: Conceptualizations*, *Groundwater V25*, No. 3, 1987 pp. 300-313.

Keith, Lawrence H., *Principles of Environmental Sampling*, American Chemical Society, 1988.

Korte, Nic, and Dennis Ealey., *Procedures for Field Chemical Analyses of Water Samples*, U.S. Department of Energy, GJ/TMC-07, Technical Measurements Center, Grand Junction Project Office, 1983.

Korte, Nic, and Peter Kearl., *Procedures for the Collection and Preservation of Groundwater and Surface Water Samples and for the Installation of Monitoring Wells: Second Edition*, U.S. Department of Energy, GJ/TMC-08, Technical Measurements Center, Grand Junction Projects Office, 1985.

National Council of the Paper Industry for Air and Stream Improvement, Inc., *A Guide to Groundwater Sampling*, Technical Bulletin No. 362, Madison, New York. January, 1982.

Nielsen, David M. and Yeates, Gillian L., Spring. "A Comparison of Sampling Mechanisms Available for Small-Diameter Groundwater Monitoring Wells," *Groundwater Monitoring Review*, 1985 pp. 83-99.

Scalf, et al. (M.J. Scalf, McNabb, W. Dunlap, R. Crosby, and J. Fryberger),. *Manual for Groundwater Sampling Procedures*. R.S. Kerr Environmental Research Laboratory, Office of Research and

Development. 1980, Ada, OK.

Sisk, S.W. NEIC Manual for Ground/Surface Investigations at Hazardous Waste Sites, EPA-330/9-81-002, 1981.

U.S. Department of the Interior, *National Handbook of Recommended Methods for Water-Data Acquisition*, Reston, Virginia.

U.S. Environmental Protection Agency, 1977. *Procedures Manual for Groundwater Monitoring at Solid Waste Disposal Facilities*. EPA-530/SW-611. August, 1977.

U.S. Code of Federal Regulations, 49 CFR Parts 100 to 177, Transportation revised November 1, 1985.

U.S. Environmental Protection Agency, 1982. *Handbook for Chemical and Sample Preservation of Water and Wastewater*, EPA-600/4-82-029, Washington, D.C.

U.S. Environmental Protection Agency, 1983. *Methods for Chemical Analysis of Water and Waste*, EPA-600/4-79-020, Washington, D.C.

U.S. Environmental Protection Agency, 1984. *Test Methods for Evaluation of Solid Waste*, EPA-SW-846, Second Edition, Washington, D.C.

U.S. Environmental Protection Agency, 1981. *Manual of Groundwater Quality Sampling Procedures*, EPA-600/2-81-160, Washington, D.C.

U.S. Environmental Protection Agency, 1985. *Practical Guide for Groundwater Sampling*, EPA-600/2-85/104, September, 1985.

U.S. Environmental Protection Agency, 1986. *RCRA Groundwater Monitoring Technical Enforcement Guidance Document*, OSWER-9950-1, September, 1986.

Weston, 1987. *Standard Operations Procedures for Monitor Well Installation*. MOUND IGMP/RIP.

U.S. Environmental Protection Agency, 1982. *Handbook for Sampling and Sample Preservation of Water and Wastewater*, EPA-600/4-82-029, Washington, D.C.

--- 1981. *Manual of Groundwater Quality*

Sampling Procedures, EPA-600/2-81-160, Washington, D.C.

--- 1985. Practice Guide for Groundwater Sampling, EPA-600/2/85-104, September 1985.

Nielsen, David M. and Yeates, Gillian L., Spring 1985. "A Comparison of Sampling Mechanisms Available for Small-Diameter Groundwater Monitoring Wells," Groundwater Monitoring Review, pp. 83-99.

WESTON, 1987. Standard Operating Procedures for Monitor Well Installation. MOUND IGMP/RIP

Barcelona, M.J. Helfrich, J.A., and Garske, E.E., "Sampling Tubing Effects on Groundwater Samples". 1985, *Analy. Chem.*, Vol. 57, pp. 460-463.



SAMPLING EQUIPMENT DECONTAMINATION

SOP#: 2006
DATE: 08/11/94
REV. #: 0.0

1.0 SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to provide a description of the methods used for preventing, minimizing, or limiting cross-contamination of samples due to inappropriate or inadequate equipment decontamination and to provide general guidelines for developing decontamination procedures for sampling equipment to be used during hazardous waste operations as per 29 Code of Federal Regulations (CFR) 1910.120. This SOP does not address personnel decontamination.

These are standard (i.e. typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitation, or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (U.S. EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

Removing or neutralizing contaminants from equipment minimizes the likelihood of sample cross contamination, reduces or eliminates transfer of contaminants to clean areas, and prevents the mixing of incompatible substances.

Gross contamination can be removed by physical decontamination procedures. These abrasive and non-abrasive methods include the use of brushes, air and wet blasting, and high and low pressure water cleaning.

The first step, a soap and water wash, removes all visible particulate matter and residual oils and grease. This may be preceded by a steam or high pressure

water wash to facilitate residuals removal. The second step involves a tap water rinse and a distilled/deionized water rinse to remove the detergent. An acid rinse provides a low pH media for trace metals removal and is included in the decontamination process if metal samples are to be collected. It is followed by another distilled/deionized water rinse. If sample analysis does not include metals, the acid rinse step can be omitted. Next, a high purity solvent rinse is performed for trace organics removal if organics are a concern at the site. Typical solvents used for removal of organic contaminants include acetone, hexane, or water. Acetone is typically chosen because it is an excellent solvent, miscible in water, and not a target analyte on the Priority Pollutant List. If acetone is known to be a contaminant of concern at a given site or if Target Compound List analysis (which includes acetone) is to be performed, another solvent may be substituted. The solvent must be allowed to evaporate completely and then a final distilled/deionized water rinse is performed. This rinse removes any residual traces of the solvent.

The decontamination procedure described above may be summarized as follows:

1. Physical removal
2. Non-phosphate detergent wash
3. Tap water rinse
4. Distilled/deionized water rinse
5. 10% nitric acid rinse
6. Distilled/deionized water rinse
7. Solvent rinse (pesticide grade)
8. Air dry
9. Distilled/deionized water rinse

If a particular contaminant fraction is not present at the site, the nine (9) step decontamination procedure specified above may be modified for site specificity. For example, the nitric acid rinse may be eliminated if metals are not of concern at a site. Similarly, the solvent rinse may be eliminated if organics are not of

concern at a site. Modifications to the standard procedure should be documented in the site specific work plan or subsequent report.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

The amount of sample to be collected and the proper sample container type (i.e., glass, plastic), chemical preservation, and storage requirements are dependent on the matrix being sampled and the parameter(s) of interest.

More specifically, sample collection and analysis of decontamination waste may be required before beginning proper disposal of decontamination liquids and solids generated at a site. This should be determined prior to initiation of site activities.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

- C The use of distilled/deionized water commonly available from commercial vendors may be acceptable for decontamination of sampling equipment provided that it has been verified by laboratory analysis to be analyte free (specifically for the contaminants of concern).
- C The use of an untreated potable water supply is not an acceptable substitute for tap water. Tap water may be used from any municipal or industrial water treatment system.
- C If acids or solvents are utilized in decontamination they raise health and safety, and waste disposal concerns.
- C Damage can be incurred by acid and solvent washing of complex and sophisticated sampling equipment.

5.0 EQUIPMENT/APPARATUS

Decontamination equipment, materials, and supplies are generally selected based on availability. Other considerations include the ease of decontaminating or disposing of the equipment. Most equipment and supplies can be easily procured. For example, soft-

bristle scrub brushes or long-handled bottle brushes can be used to remove contaminants. Large galvanized wash tubs, stock tanks, or buckets can hold wash and rinse solutions. Children's wading pools can also be used. Large plastic garbage cans or other similar containers lined with plastic bags can help segregate contaminated equipment. Contaminated liquid can be stored temporarily in metal or plastic cans or drums.

The following standard materials and equipment are recommended for decontamination activities:

5.1 Decontamination Solutions

- C Non-phosphate detergent
- C Selected solvents (acetone, hexane, nitric acid, etc.)
- C Tap water
- C Distilled or deionized water

5.2 Decontamination Tools/Supplies

- C Long and short handled brushes
- C Bottle brushes
- C Drop cloth/plastic sheeting
- C Paper towels
- C Plastic or galvanized tubs or buckets
- C Pressurized sprayers (H₂O)
- C Solvent sprayers
- C Aluminum foil

5.3 Health and Safety Equipment

Appropriate personal protective equipment (i.e., safety glasses or splash shield, appropriate gloves, aprons or coveralls, respirator, emergency eye wash)

5.4 Waste Disposal

- C Trash bags
- C Trash containers
- C 55-gallon drums
- C Metal/plastic buckets/containers for storage and disposal of decontamination solutions

6.0 REAGENTS

There are no reagents used in this procedure aside from the actual decontamination solutions. Table 1 (Appendix A) lists solvent rinses which may be required for elimination of particular chemicals. In

general, the following solvents are typically utilized for decontamination purposes:

- C 10% nitric acid is typically used for inorganic compounds such as metals. An acid rinse may not be required if inorganics are not a contaminant of concern.
- C Acetone (pesticide grade)⁽¹⁾
- C Hexane (pesticide grade)⁽¹⁾
- C Methanol⁽¹⁾

⁽¹⁾ - Only if sample is to be analyzed for organics.

7.0 PROCEDURES

As part of the health and safety plan, a decontamination plan should be developed and reviewed. The decontamination line should be set up before any personnel or equipment enter the areas of potential exposure. The equipment decontamination plan should include:

- C The number, location, and layout of decontamination stations.
- C Decontamination equipment needed.
- C Appropriate decontamination methods.
- C Methods for disposal of contaminated clothing, equipment, and solutions.
- C Procedures can be established to minimize the potential for contamination. This may include: (1) work practices that minimize contact with potential contaminants; (2) using remote sampling techniques; (3) covering monitoring and sampling equipment with plastic, aluminum foil, or other protective material; (4) watering down dusty areas; (5) avoiding laying down equipment in areas of obvious contamination; and (6) use of disposable sampling equipment.

7.1 Decontamination Methods

All samples and equipment leaving the contaminated area of a site must be decontaminated to remove any contamination that may have adhered to equipment. Various decontamination methods will remove contaminants by: (1) flushing or other physical action, or (2) chemical complexing to inactivate

contaminants by neutralization, chemical reaction, disinfection, or sterilization.

Physical decontamination techniques can be grouped into two categories: abrasive methods and non-abrasive methods, as follows:

7.1.1 Abrasive Cleaning Methods

Abrasive cleaning methods work by rubbing and wearing away the top layer of the surface containing the contaminant. The mechanical abrasive cleaning methods are most commonly used at hazardous waste sites. The following abrasive methods are available:

Mechanical

Mechanical methods of decontamination include using metal or nylon brushes. The amount and type of contaminants removed will vary with the hardness of bristles, length of time brushed, degree of brush contact, degree of contamination, nature of the surface being cleaned, and degree of contaminant adherence to the surface.

Air Blasting

Air blasting equipment uses compressed air to force abrasive material through a nozzle at high velocities. The distance between nozzle and surface cleaned, air pressure, time of application, and angle at which the abrasive strikes the surface will dictate cleaning efficiency. Disadvantages of this method are the inability to control the amount of material removed and the large amount of waste generated.

Wet Blasting

Wet blast cleaning involves use of a suspended fine abrasive. The abrasive/water mixture is delivered by compressed air to the contaminated area. By using a very fine abrasive, the amount of materials removed can be carefully controlled.

7.1.2 Non-Abrasive Cleaning Methods

Non-abrasive cleaning methods work by forcing the contaminant off a surface with pressure. In general, the equipment surface is not removed using non-abrasive methods.

Low-Pressure Water

This method consists of a container which is filled with water. The user pumps air out of the container to create a vacuum. A slender nozzle and hose allow the user to spray in hard-to-reach places.

High-Pressure Water

This method consists of a high-pressure pump, an operator controlled directional nozzle, and a high-pressure hose. Operating pressure usually ranges from 340 to 680 atmospheres (atm) and flow rates usually range from 20 to 140 liters per minute.

Ultra-High-Pressure Water

This system produces a water jet that is pressured from 1,000 to 4,000 atmospheres. This ultra-high-pressure spray can remove tightly-adhered surface films. The water velocity ranges from 500 meters/second (m/s) (1,000 atm) to 900 m/s (4,000 atm). Additives can be used to enhance the cleaning action.

Rinsing

Contaminants are removed by rinsing through dilution, physical attraction, and solubilization.

Damp Cloth Removal

In some instances, due to sensitive, non-waterproof equipment or due to the unlikelihood of equipment being contaminated, it is not necessary to conduct an extensive decontamination procedure. For example, air sampling pumps hooked on a fence, placed on a drum, or wrapped in plastic bags are not likely to become heavily contaminated. A damp cloth should be used to wipe off contaminants which may have adhered to equipment through airborne contaminants or from surfaces upon which the equipment was set.

Disinfection/Sterilization

Disinfectants are a practical means of inactivating infectious agents. Unfortunately, standard sterilization methods are impractical for large equipment. This method of decontamination is typically performed off-site.

7.2 Field Sampling Equipment Decontamination Procedures

The decontamination line is setup so that the first station is used to clean the most contaminated item. It progresses to the last station where the least contaminated item is cleaned. The spread of contaminants is further reduced by separating each decontamination station by a minimum of three (3) feet. Ideally, the contamination should decrease as the equipment progresses from one station to another farther along in the line.

A site is typically divided up into the following boundaries: Hot Zone or Exclusion Zone (EZ), the Contamination Reduction Zone (CRZ), and the Support or Safe Zone (SZ). The decontamination line should be setup in the Contamination Reduction Corridor (CRC) which is in the CRZ. Figure 1 (Appendix B) shows a typical contaminant reduction zone layout. The CRC controls access into and out of the exclusion zone and confines decontamination activities to a limited area. The CRC boundaries should be conspicuously marked. The far end is the hotline, the boundary between the exclusion zone and the contamination reduction zone. The size of the decontamination corridor depends on the number of stations in the decontamination process, overall dimensions of the work zones, and amount of space available at the site. Whenever possible, it should be a straight line.

Anyone in the CRC should be wearing the level of protection designated for the decontamination crew. Another corridor may be required for the entry and exit of heavy equipment. Sampling and monitoring equipment and sampling supplies are all maintained outside of the CRC. Personnel don their equipment away from the CRC and enter the exclusion zone through a separate access control point at the hotline. One person (or more) dedicated to decontaminating equipment is recommended.

7.2.1 Decontamination Setup

Starting with the most contaminated station, the decontamination setup should be as follows:

Station 1: Segregate Equipment Drop

Place plastic sheeting on the ground (Figure 2, Appendix B). Size will depend on amount of

equipment to be decontaminated. Provide containers lined with plastic if equipment is to be segregated. Segregation may be required if sensitive equipment or mildly contaminated equipment is used at the same time as equipment which is likely to be heavily contaminated.

Station 2: Physical Removal With A High-Pressure Washer (Optional)

As indicated in 7.1.2, a high-pressure wash may be required for compounds which are difficult to remove by washing with brushes. The elevated temperature of the water from the high-pressure washers is excellent at removing greasy/oily compounds. High pressure washers require water and electricity.

A decontamination pad may be required for the high-pressure wash area. An example of a wash pad may consist of an approximately 1 1/2 foot-deep basin lined with plastic sheeting and sloped to a sump at one corner. A layer of sand can be placed over the plastic and the basin is filled with gravel or shell. The sump is also lined with visqueen and a barrel is placed in the hole to prevent collapse. A sump pump is used to remove the water from the sump for transfer into a drum.

Typically heavy machinery is decontaminated at the end of the day unless site sampling requires that the machinery be decontaminated frequently. A separate decontamination pad may be required for heavy equipment.

Station 3: Physical Removal With Brushes And A Wash Basin

Prior to setting up Station 3, place plastic sheeting on the ground to cover areas under Station 3 through Station 10.

Fill a wash basin, a large bucket, or child's swimming pool with non-phosphate detergent and tap water. Several bottle and bristle brushes to physically remove contamination should be dedicated to this station. Approximately 10 - 50 gallons of water may be required initially depending upon the amount of equipment to decontaminate and the amount of gross contamination.

Station 4: Water Basin

Fill a wash basin, a large bucket, or child's swimming

pool with tap water. Several bottle and bristle brushes should be dedicated to this station. Approximately 10-50 gallons of water may be required initially depending upon the amount of equipment to decontaminate and the amount of gross contamination.

Station 5: Low-Pressure Sprayers

Fill a low-pressure sprayer with distilled/deionized water. Provide a 5-gallon bucket or basin to contain the water during the rinsing process. Approximately 10-20 gallons of water may be required initially depending upon the amount of equipment to decontaminate and the amount of gross contamination.

Station 6: Nitric Acid Sprayers

Fill a spray bottle with 10% nitric acid. An acid rinse may not be required if inorganics are not a contaminant of concern. The amount of acid will depend on the amount of equipment to be decontaminated. Provide a 5-gallon bucket or basin to collect acid during the rinsing process.

Station 7: Low-Pressure Sprayers

Fill a low-pressure sprayer with distilled/deionized water. Provide a 5-gallon bucket or basin to collect water during the rinsate process.

Station 8: Organic Solvent Sprayers

Fill a spray bottle with an organic solvent. After each solvent rinse, the equipment should be rinsed with distilled/deionized water and air dried. Amount of solvent will depend on the amount of equipment to decontaminate. Provide a 5-gallon bucket or basin to collect the solvent during the rinsing process.

Solvent rinses may not be required unless organics are a contaminant of concern, and may be eliminated from the station sequence.

Station 9: Low-Pressure Sprayers

Fill a low-pressure sprayer with distilled/deionized water. Provide a 5-gallon bucket or basin to collect water during the rinsate process.

Station 10: Clean Equipment Drop

Lay a clean piece of plastic sheeting over the bottom

plastic layer. This will allow easy removal of the plastic in the event that it becomes dirty. Provide aluminum foil, plastic, or other protective material to wrap clean equipment.

7.2.2 Decontamination Procedures

Station 1: Segregate Equipment Drop

Deposit equipment used on-site (i.e., tools, sampling devices and containers, monitoring instruments radios, clipboards, etc.) on the plastic drop cloth/sheet or in different containers with plastic liners. Each will be contaminated to a different degree. Segregation at the drop reduces the probability of cross contamination. Loose leaf sampling data sheets or maps can be placed in plastic zip lock bags if contamination is evident.

Station 2: Physical Removal With A High-Pressure Washer (Optional)

Use high pressure wash on grossly contaminated equipment. Do not use high- pressure wash on sensitive or non-waterproof equipment.

Station 3: Physical Removal With Brushes And A Wash Basin

Scrub equipment with soap and water using bottle and bristle brushes. Only sensitive equipment (i.e., radios, air monitoring and sampling equipment) which is waterproof should be washed. Equipment which is not waterproof should have plastic bags removed and wiped down with a damp cloth. Acids and organic rinses may also ruin sensitive equipment. Consult the manufacturers for recommended decontamination solutions.

Station 4: Equipment Rinse

Wash soap off of equipment with water by immersing the equipment in the water while brushing. Repeat as many times as necessary.

Station 5: Low-Pressure Rinse

Rinse sampling equipment with distilled/deionized water with a low-pressure sprayer.

Station 6: Nitric Acid Sprayers (required only if metals are a contaminant of concern)

Using a spray bottle rinse sampling equipment with nitric acid. Begin spraying (inside and outside) at one end of the equipment allowing the acid to drip to the other end into a 5-gallon bucket. A rinsate blank may be required at this station. Refer to Section 9.

Station 7: Low-Pressure Sprayers

Rinse sampling equipment with distilled/deionized water with a low-pressure sprayer.

Station 8: Organic Solvent Sprayers

Rinse sampling equipment with a solvent. Begin spraying (inside and outside) at one end of the equipment allowing the solvent to drip to the other end into a 5-gallon bucket. Allow the solvent to evaporate from the equipment before going to the next station. A QC rinsate sample may be required at this station.

Station 9: Low-Pressure Sprayers

Rinse sampling equipment with distilled/deionized water with a low-pressure washer.

Station 10: Clean Equipment Drop

Lay clean equipment on plastic sheeting. Once air dried, wrap sampling equipment with aluminum foil, plastic, or other protective material.

7.2.3 Post Decontamination Procedures

1. Collect high-pressure pad and heavy equipment decontamination area liquid and waste and store in appropriate drum or container. A sump pump can aid in the collection process. Refer to the Department of Transportation (DOT) requirements for appropriate containers based on the contaminant of concern.
2. Collect high-pressure pad and heavy equipment decontamination area solid waste and store in appropriate drum or container. Refer to the DOT requirements for appropriate containers based on the contaminant of concern.
3. Empty soap and water liquid wastes from basins and buckets and store in appropriate

drum or container. Refer to the DOT requirements for appropriate containers based on the contaminant of concern.

4. Empty acid rinse waste and place in appropriate container or neutralize with a base and place in appropriate drum. pH paper or an equivalent pH test is required for neutralization. Consult DOT requirements for appropriate drum for acid rinse waste.
5. Empty solvent rinse sprayer and solvent waste into an appropriate container. Consult DOT requirements for appropriate drum for solvent rinse waste.
6. Using low-pressure sprayers, rinse basins, and brushes. Place liquid generated from this process into the wash water rinse container.
7. Empty low-pressure sprayer water onto the ground.
8. Place all solid waste materials generated from the decontamination area (i.e., gloves and plastic sheeting, etc.) in an approved DOT drum. Refer to the DOT requirements for appropriate containers based on the contaminant of concern.
9. Write appropriate labels for waste and make arrangements for disposal. Consult DOT regulations for the appropriate label for each drum generated from the decontamination process.

8.0 CALCULATIONS

This section is not applicable to this SOP.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

A rinsate blank is one specific type of quality control sample associated with the field decontamination process. This sample will provide information on the effectiveness of the decontamination process employed in the field.

Rinsate blanks are samples obtained by running analyte free water over decontaminated sampling

equipment to test for residual contamination. The blank water is collected in sample containers for handling, shipment, and analysis. These samples are treated identical to samples collected that day. A rinsate blank is used to assess cross contamination brought about by improper decontamination procedures. Where dedicated sampling equipment is not utilized, collect one rinsate blank per day per type of sampling device samples to meet QA2 and QA3 objectives.

If sampling equipment requires the use of plastic tubing it should be disposed of as contaminated and replaced with clean tubing before additional sampling occurs.

10.0 DATA VALIDATION

Results of quality control samples will be evaluated for contamination. This information will be utilized to qualify the environmental sample results in accordance with the project's data quality objectives.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow OSHA, U.S. EPA, corporate, and other applicable health and safety procedures.

Decontamination can pose hazards under certain circumstances. Hazardous substances may be incompatible with decontamination materials. For example, the decontamination solution may react with contaminants to produce heat, explosion, or toxic products. Also, vapors from decontamination solutions may pose a direct health hazard to workers by inhalation, contact, fire, or explosion.

The decontamination solutions must be determined to be acceptable before use. Decontamination materials may degrade protective clothing or equipment; some solvents can permeate protective clothing. If decontamination materials do pose a health hazard, measures should be taken to protect personnel or substitutions should be made to eliminate the hazard. The choice of respiratory protection based on contaminants of concern from the site may not be appropriate for solvents used in the decontamination process.

Safety considerations should be addressed when using abrasive and non-abrasive decontamination

equipment. Maximum air pressure produced by abrasive equipment could cause physical injury. Displaced material requires control mechanisms.

Material generated from decontamination activities requires proper handling, storage, and disposal. Personal Protective Equipment may be required for these activities.

Material safety data sheets are required for all decontamination solvents or solutions as required by the Hazard Communication Standard (i.e., acetone, alcohol, and trisodiumphosphate).

In some jurisdictions, phosphate containing detergents (i.e., TSP) are banned.

12.0 REFERENCES

Field Sampling Procedures Manual, New Jersey Department of Environmental Protection, February, 1988.

A Compendium of Superfund Field Operations Methods, EPA 540/p-87/001.

Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual, USEPA Region IV, April 1, 1986.

Guidelines for the Selection of Chemical Protective Clothing, Volume 1, Third Edition, American Conference of Governmental Industrial Hygienists, Inc., February, 1987.

Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, NIOSH/OSHA/USCG/EPA, October, 1985.

APPENDIX A

Table

Table 1. Soluble Contaminants and Recommended Solvent Rinse

| TABLE 1 Soluble Contaminants and Recommended Solvent Rinse | | |
|---|--|--|
| SOLVENT ⁽¹⁾ | EXAMPLES OF SOLVENTS | SOLUBLE CONTAMINANTS |
| Water | Deionized water Tap water | Low-chain hydrocarbons Inorganic compounds Salts Some organic acids and other polar compounds |
| Dilute Acids | Nitric acid Acetic acid Boric acid | Basic (caustic) compounds (e.g., amines and hydrazines) |
| Dilute Bases | Sodium bicarbonate (e.g., soap detergent) | Acidic compounds Phenol Thiols Some nitro and sulfonic compounds |
| Organic Solvents ⁽²⁾ | Alcohols Ethers Ketones Aromatics Straight chain alkalines (e.g., hexane) Common petroleum products (e.g., fuel, oil, kerosene) | Nonpolar compounds (e.g., some organic compounds) |
| Organic Solvent ⁽²⁾ | Hexane | PCBs |

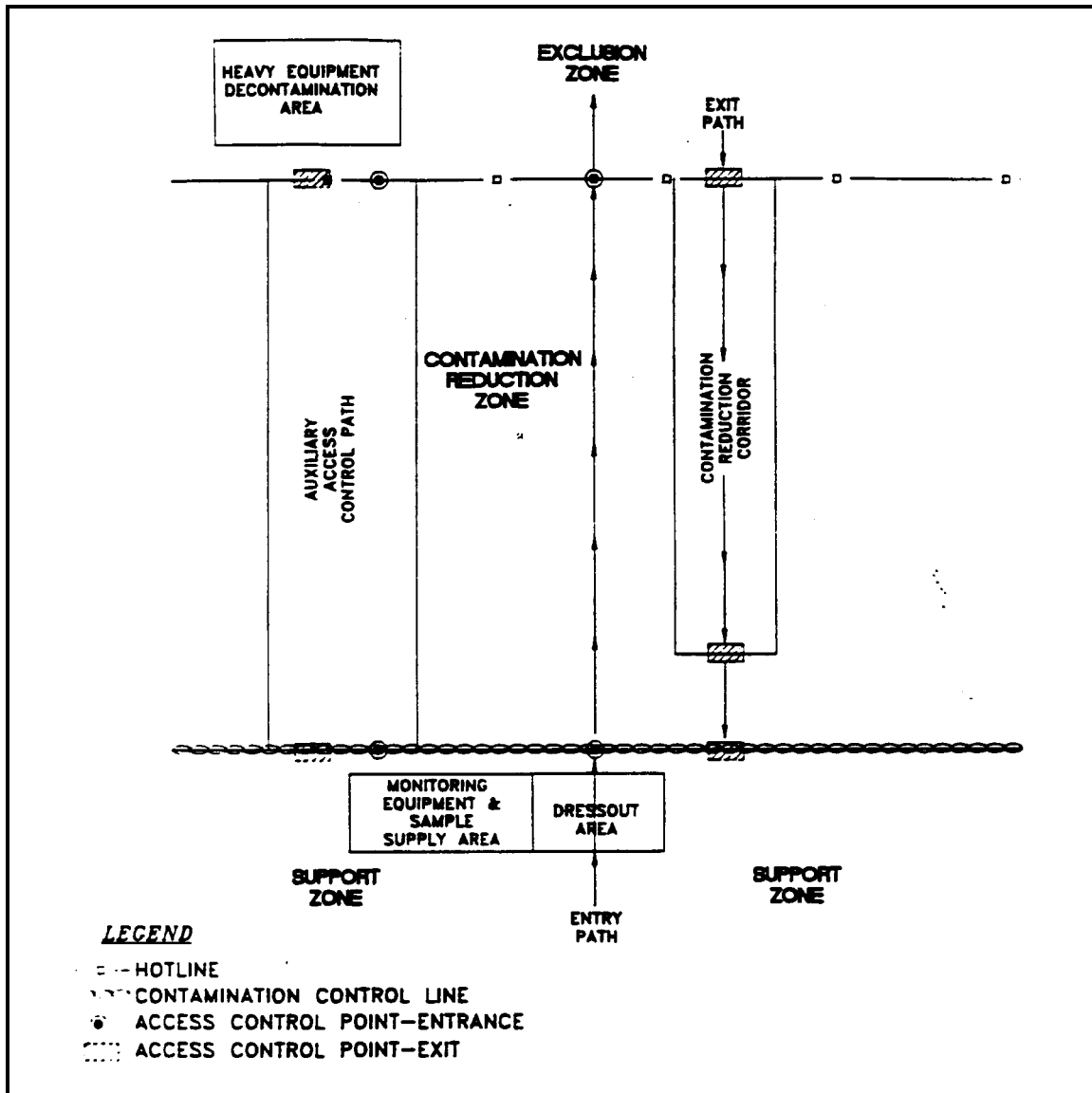
⁽¹⁾ - Material safety data sheets are required for all decontamination solvents or solutions as required by the Hazard Communication Standard

⁽²⁾ - WARNING: Some organic solvents can permeate and/or degrade the protective clothing

APPENDIX B

Figures

Figure 1. Contamination Reduction Zone Layout



APPENDIX B (Cont'd.)

Figures

Figure 2. Decontamination Layout

